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COMPOUND-WOUND DYNAMOS.

"Is discretion always the better part of valour?" was, we imagine, the question asked by various dynamo manufacturers on hearing that the case of the Anglo-American Brush Corporation against Crompton & Co. was withdrawn. We do not know on what terms the compromise was made, but we imagine that Messrs. Crompton had a strong case. If they had, it would still be possible that Messrs. Crompton may have argued that if they fought the action out and won it they would still lose money, as in these patent actions the costs obtained by the victors, when they get costs at all, are a small part only of the expenses incurred, and they may have, therefore, compromised with the Brush Corporation, which, on its part, would naturally prefer not to risk a patent if there were means of retaining it without the risk. Under such circumstances, or under circumstances like them, we cannot blame either the Brush Corporation or Messrs. Crompton; the fault really lies in the enormous expense of the adminstration of justice.

We question, however, whether leading manufacturers in such cases are quite justified in considering themselves alone. It is clear that by such combination great injustice may be done or is done to the smaller firms. If the Brush Corporation is entitled to the patent no injustice is done, of course; but if, as we think, they are not entitled to any monopoly of compound winding, the small makers have no chance of getting justice. If a large firm threatens a monopoly it is evidently impossible for small firms to fight them; the risks would be too great, and even winning would not be worth the loss by expenses. The only chance they have in cases of the kind is, that some other large firm, whose business is important enough to make such a proceeding worth while, may oppose the threatened monopoly. If the large makers give in and pay for licences it might be presumed that the patent is good, but it is quite possible that the patent is bad, and that the large makers get better terms than the small ones, in which case the result is nothing better than a sort of ring. The action of the large makers actually strengthens the patent, and the small makers, who are already pressing the large manufacturers hard in the matter of price are at an unfair disadvantage.

As to the validity of the Brush patent, many may be found to question it. Our readers may remember that we were the first to bring forward S. A. Varley's claim to be the inventor of compound-winding. We published on Sept 26th, 1885, a paper by Mr. J. S. Beeman, giving an excerpt from Varley's specification. We were ourselves aware of the existence of this all along; as a matter of fact, we had made the drawings for it. Now, no one can read that part of Varley's specification through impartially without seeing that it is a complete publication of a winding consisting of two wires on the field magnets, one being in series and the other in shunt. A machine was made, following the specification, by Messrs. Siebe & Gorman, and this, a reproduction of which may be seen in our other pages, is still in existence. It is wound with two wires, one of high resistance and the other low, and was worked with them coupled in main circuit and shunt. It is a curious fact, as we pointed out in 1885, that Varley not only anticipates Brush as to the main and high resistance shunt winding, but he cuts out his armature coils at the neutral point with a commutator very closely resembling Brush's. The wires are also brought through a hollow shaft, and the end view of Varley's commutator in his specification looks exactly like that of Brush. If we are not in error, Varley's machine has detachable commutator segments, and that alone might possibly invalidate Brush's patent. In addition to this the general design and arrangement of Varley's machine distinctly resembles Brush's, the magnets being parallel to the axle with end bearings on the castings that serve as the magnet yokes. The armature itself, however, more closely resembles Wallace's in construction, though it is like Brush's in having no current through the coils when in the neutral position. We do not for a moment mean to insinuate that Brush copied Varley. We have far too high an opinion of that eminent inventor to imagine such a thing; but we wish to point out that Varley is a man who most certainly knew what he was about.

Of course winding the magnets with a main and shunt as Varley did does not constitute what is now known as compound-winding. By compound-winding, a term introduced, we believe, by Crompton and Kapp, is now meant winding for constant potential. Neither Brush nor Varley say anything about this. The object of both was to make a machine that would not lose its field, or, as Brush puts it, which would maintain a "permanent field." Whether Brush described what is now known as compound-winding or not is immaterial as far as the validity of Brush's patent is concerned, as his claim can hardly be for anything but the double-winding, which was fully explained by Varley.

It will be remembered, however, that Crompton and Kapp brought a counter action against the Brush Corporation, claiming a monopoly on their patent of 1882. The question whether Brush invented compound-winding of course bears on this patent. Though Crompton and Kapp claim a monopoly on this patent, they seem to have intended to use it more as a weapon of war against the Brush Corporation than with the idea of claiming a monopoly generally.

It is difficult to say who invented compound-winding. Probably, like most inventions, it grew. Neither Varley nor Brush say anything about it. The object in both their specifications is the maintenance of a "permanent field," not necessarily of constant electromotive force. Marcel Deprez perhaps did most, as in 1881 he made a constant electromotive force machine by combining a series and a separately excited dynamo. In the number following that containing Mr. Beeman's

report, Mr. Swinburne writes claiming that he was the first to use compound self-exciting machines early in 1882. He brings forward no evidence; but the strange part of the whole business is that he claims to have told Brush how to make compound machines early in 1882, and to have afterwards filed an application for an American patent on which was declared an interference, not with Brush, but with Edison. Now Mr. Swinburne, we understand, went to America this autumn to cross-examine Mr. Brush, and we should very much like to see the resulting evidence. Mr. Brush does not appear to have published anything about compound-winding; and we believe we were the first to publish it in an article on October 7th, 1882. Crompton and Kapp filed their application a few days later, so we can hardly think their patent is valid, or that here is any chance of their ever getting a monopoly. Professor Silvanus Thompson also described compound-winding a few months later in his Cantor Lectures. All the same, the credit of its introduction is certainly due to Crompton & Co., who put compound-wound machines into the market long before other makers. It is obvious that if Brush had really described compound-winding the Brush Corporation would have made compound machines, but they did not do so till long after Crompton had taken the initiative.

As already explained, the validity of the Brush patent does not depend on whether he invented what is now known as compound winding, or not; as his claim is for main and high resistance shunt winding. He originally claimed shunt winding pure and simple as well as the combination as his invention, and though he says he prefers the latter, especially for electroplating, for which, by the way, it is least suited, he describes the shunt and the combination winding as both available for producing what he wants, namely, a "permanent field."

Finally, we must say that we very much regret, for the sake of the trade generally, that this action was not fought out. No doubt the firms were wise from their own point of view to make an arrangement, but a system of compromise between large firms with the intentional or unintentional result of oppressing smaller makers is essentially unjust and pernicious.

A PAGE-CIRCULAR, entitled "Electric Advantages for the Million," which has been handed to us, informs the public that patents have this year been secured for a new insulating compound and a wire of increased strength and power of conductivity, and that the public authorities and engineers can easily obtain licenses to use these inventions by applying to the secretary of the Engineering and Sanitary Association. We further learn that the tests given to these discoveries enable the association to recommend their employment as the means whereby many electrical advantages can become general. The insulating compound is said to be composed of two non-oxydisable substances, the main recommendation of one of these being that it was used for the preservation of Egyptian mummies. What the wire is we have yet to learn, but we should not be surprised if it turns out to have a "Cross section. We know from ancient lore that the Egyptians were a warm lot, but surely when "insulated" for some thousands of years they did not become more highly incandescent and prove the material to be heat-resisting; yet, in the present case, that is the only reason we can assign to account for Mr. Donald Nicoll's advocacy of his special bituminous compound as a covering for wires.

IT has been suggested to us that the Society of Telegraph-Engineers and Electricians might become more popular than appears now to be the case with a certain section of the electrical fraternity, if the worthy secretary took upon himself the task of hunting up those members or non-members of the society who are specialists in their own particular branches of study, with the view of securing such important papers as have for some years past fallen to the lot of the Institution of Civil Engineers. The great success of the latter and the prestige attached to the reading of papers before its members, is in no small degree due to the energy and tact of its popular secretary.

WHY cannot the voting for the election of the president and members of the Council of the Society of Telegraph-Engineers be carried out entirely through the post? Surely this would save a considerable amount of time on the night of the election, which might well be devoted to more useful purposes, as the ballot of the members might be made known at the commencement of the meeting, and this need not occupy more than a few minutes.

WE understand that another powerful company is about to enter the electric lighting lists with a transformer system. Experiments with apparatus of large size have given excellent results.

ALTHOUGH the details of the Bessbrook and Newry tramway are to a considerable extent already known to the readers of this journal, we shall shortly hope to place before them the admirable paper on the same subject which Dr. Edward Hopkinson read last Tuesday at the meeting of the Institution of Civil Engineers. When the line was projected, the following conditions were to be met:—Ten trains to be run in each direction per day, providing for a daily traffic each way of 100 tons of minerals and goods, and capable of dealing with 200 tons in any single day, in addition to the passenger traffic; the electric locomotive to be capable of drawing a gross load of 18 tons on the up-journey, in addition to the tare of the car itself and its full complement of passengers at an average speed of 6 miles per hour, and a load of 12 tons at an average speed of 9 miles an hour. It was also necessary to show that the cost of working during a six months' trial did not exceed that of steam traction on a similar line. These conditions being complied with, the tramway, which is over three miles in length, with a maximum gradient of 1 in 50, was opened for traffic in October, 1885, and has been in daily operation since.

IT is gratifying to learn that the Spiel Petroleum Engine Company has been enabled to pay a dividend of 4 per cent. to its shareholders. No less than £3,000 in royalties, the minimum amount due to the company for the period ending June 30th last, had been paid by Messrs. Shirlaw, the manufacturers of the engines, which we hope represents a considerable amount of actual business, the number of orders on hand and the enquiries respecting the engine being of a very satisfactory nature. We have always advocated the employment of these prime motors, and it is a source of pleasure to us to know that their merits are gradually meeting with recognition.

ON THE APPLICATION OF THE DECI-AMPERE OR THE CENTI-AMPERE BALANCE TO THE DETERMINATION OF THE ELECTROMOTIVE FORCES OF VOLTAIC CELLS.

By Sir WILLIAM THOMSON, F.R.S.*

THE method described in this paper for the determination, in absolute measure, of the electromotive forces of voltaic cells, consists in the use of one of my standard ampère balances instead of the tangent galvanometer in the method given in the following statement,† which I quote from Kohlrausch's "Physical Measurements," pp. 223, 224, 230 :—"The only methods applicable to inconstant elements, of which the electromotive force varies with the current strength, is to bring the current to zero by opposing an equal electromotive force. Poggendorff's method, which is very convenient, as it involves no measurement of internal resistance, requires the use of a galvanoscope, G, a galvanometer, T, and a rheostat, R, and, in addition, that of an auxiliary battery, S, of constant electromotive force, greater than either of those which are to be compared. The arrangement of the experiment is shown in the figure. In the left division of the circuit

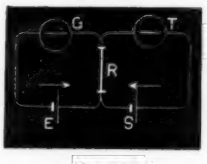


FIG. 1.

are the galvanoscope, G, and the electromotive force, E, to be measured ; in the right, the auxiliary battery, S, and the galvanometer, T. E and S are so placed that their similar poles are turned towards each other. In the middle part of the circuit, which is common to both batteries, is the rheostat, R.

"As much rheostat resistance, W, must now be intercalated as will cause the current in E G to vanish, and the current strength, J, in T, must then be observed. . . . . If J = current strength in T, the electromotive force of the battery, E, is E = W J."

The deci-ampère balance, or, when a sufficient number of battery cells is available, the centi-ampère balance, answers well for the current measurements here required. An arrangement of the circuit which is convenient for most purposes is shown in the diagram (fig. 2) ; but it may be remarked that the reversing keys there shown may be replaced by ordinary make-break keys. Referring to the diagram, a battery of a sufficient number of cells is joined in circuit through a reversing key with a rheostat, a deci-ampère balance, and a standard resistance. The poles of the cell to be tested are connected in circuit with a key and a sensitive mirror galvanometer to the two ends of the standard resistance in such a way that both the battery and the cell to be tested tend to send a current in the same direction through that resistance. Care should be taken that the circuit of the cell to be tested is well insulated, and that both it and the standard resistance are free from other electromotive force. When, as in the case of Clark-standard cells, the cell is incapable of maintaining a current, a high-resistance galvanometer or an additional resistance should be included in its circuit. If very great sensibility is not required, a quadrant electrometer may in such cases be substituted for the galvanometer. The standard resistance must be of such a form that no sensible error is introduced through heating by the passage of the current. A good plan is to wind well-insulated platinoid wire in one layer on the outside of a brass or copper cylindrical vessel which can be filled with water. The temperature of the water, when it is nearly the same as that of the air outside, will be very approximately the temperature of the coil. For still greater accuracy the cylinder may be fitted with a jacket and immersed in a vessel of water, and appliances introduced for changing the water in each part and keeping account of its temperature. For use with the deci-ampère balance, a platinoid resistance of two ohms is sufficient for any single cell. A resistance of two ohms, made of insulated platinoid wire one millimetre in diameter, and wound on a brass tube capable of holding half a litre of water and simply exposed to the air outside, will carry a current of one ampère for an hour without changing its resistance more than a tenth per cent. The water should be

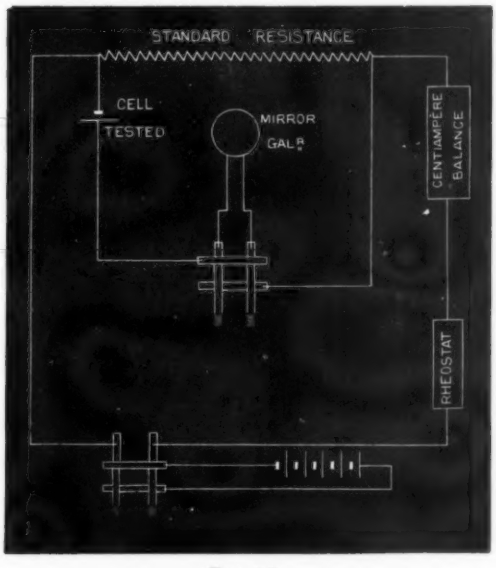


FIG. 2.*

stirred when the readings are taken, and, if necessary, the change of resistance can be approximately allowed for by taking its temperature. To measure by means of the deci-ampère balance an electromotive force of from one to two volts, a battery of two small secondary cells of four Daniell cells, a resistance of two ohms such as has just been described, with the other appliances as indicated in the figure, are all that is necessary.

The method has been applied in my laboratory by Mr. Thomas Gray for the measurement of the electromotive forces of standard and other cells, and has been found very convenient. The results obtained for four Clark-standard cells set up by Mr. J. T. Bottomley in March last were almost identical with one another, and gave 1·439 Rayleigh, or 1·442 legal, volts at 11° C. The variation of the electromotive force of these cells with temperature has not yet been determined ; but assuming the average value obtained for this variation by Lord Rayleigh, namely a fall of ·077 per cent. per degree centigrade rise of temperature, and correcting to 15° C., we obtain slightly under 1·436 Rayleigh volts at that temperature. This result is interesting as showing a difference of less than $\frac{1}{15}$th per cent. from that obtained by Lord Rayleigh for similar cells, which was 1·435 at 15° C.

* Communicated by the author to the *Philosophical Magazine*, being a paper read at the Manchester Meeting of the British Association, with additions.

† Kohlrausch was, I believe, the first to show that Poggendorff's method, when a standard galvanometer is available for measurement of currents in absolute measure, can be applied to the determination of *the electromotive force of a cell in absolute measure*. Poggendorff's method, as generally given, is merely for the comparison of the electromotive forces of two cells.—W. T., November 30th, 1887.

* In this figure the galvanometer may be represented by a quadrant electrometer, and the centi-ampère balance may be read as deci-ampère.—EDS. ELEC. REV.

THE ROYAL JUBILEE EXHIBITION, MANCHESTER, 1887.

IN very large installations of the electric light, amongst the important considerations which bear upon the question of ultimate success, there is one which merits more attention than is perhaps usually accorded to it; its necessary function is simply admitted and no special attention appears directed to the manner in which it is to be carried out. We allude to the transmission of power from the prime motor to the dynamo, and it will be acknowledged that particular attention ought to be directed to, not only the relation of driving wheels to pulleys and their relative distances from centres, but also the best type of belting to be used according to varying circumstances.

In the exhibition which has just closed and where 35 dynamos have been daily running, some experience should be gained from the behaviour of the various systems of belting tried, after six months' use or a series of intermittent runs extending to about 600 hours. In a previous article (April 29th, p. 401) we alluded to the driving belts not having performed well in some preliminary runs, but we preferred leaving the general question of belting used until such time as the exhibition had closed, when the performances of the several types might be advantageously contrasted.

There were three kinds of belting used for driving and for transmitting between the counter-shafting and the dynamos; cotton, woven hair and link belting, and including a set of ropes used in connection with one engine only, there were altogether 46 belts or transmitters of power. From the first it was seen that the short distance from centre to centre—18 feet—with the large fly wheels and pulleys, did not act in the most favourable way for the belts, as the grip on the pulley was rendered smaller. The diameter of the fly wheels was about 12 feet and the width varied from 14 inches to 22¼ inches. With regard to six of the 15-light Brush dynamos the distance of the centres was as low as 12 feet. The following results of the indicated horse-power of the engines driving the Brush dynamos will be of interest, as showing the power to be transmitted by the belts :—

No. 1	engine	70	revs.	125	I.H.P.
„ 2	„	76	„	149	„
„ 3	„	70	„	153	„
„ 4	„	76	„	134	„
„ 5	„	vertical	„	38	„
„ 6	„	ropes	„	155	„

The last engine, driven by ropes, had a fly wheel 16 feet in diameter, whilst the vertical engine drove two dynamos direct. The cotton belting did not give that amount of satisfaction expected and several changes were rendered necessary; on two or three occasions a belt was thrown off by a sudden change in the circuit. The link belting was that of Messrs. Tullis, of Glasgow, and four of their patent arched chain belts were used for driving the dynamos from Mather and Platt's engines; these belts were arched on both sides and unquestionably they experienced a severe trial by passing under the jockey pulley attached to the dynamos; the belts, however, have given the greatest satisfaction. Another of these link belts was used with No. 3 engine; this was an arched belt 1 inch thick and 23 inches wide, of a total length of 61 feet; in the short drive this belt was found to answer very well. The whole of the Brush dynamos were driven by the woven hair belting of the Rossendale Belting Company, and several of the main drives were also of the same company's make. This belting has deservedly come into much favour, and as a belt for dynamo work the present exhibition will have demonstrated its value. These belts are made by the patent anti-friction process, which effectually resists the action of the strap fork, and renders them durable, economical, efficient and strong. In the manufacture of these belts the warp and weft are woven with a composition which lubricates itself and keeps the belt in a constantly moist condition, thus giving the belt that grip upon the dynamo pulleys which is so much desired. The nature of the material used in these belts renders them impervious to the action of cold, damp, heat or gaseous air. Of the total number of 44 belts in use at the close of the exhibition as many as 28 were of the Rossendale woven hair description. Mr. W. A. Bryson, the electrician to the exhibition, has expressed himself in every way satisfied with the manner in which these belts have acquitted themselves and of the plan upon which they have been jointed.

We have mentioned the success attending the electric lighting of this exhibition, and at its closing, in referring to the question, it was observed that the lighting from the beginning to the end was most satisfactory. This has been so most unquestionably so far as the electrical installation itself is concerned, but it cannot be considered as having been absolutely perfect from the fact that external causes had on several occasions interfered with the regularity of the electrical action. Thus, for instance, in the early part of the exhibition the irregularity of some of the belts to which we have referred slightly interfered with a few of the arc lights; and in some stormy weather rain got admitted through the broken glass into the dynamo room and necessitated the stoppage of a circuit. As regards the necessity of changing any circuit or dynamo, it was found that the switchboard arrangement of the Brush Company was very rapid and effective. An interruption was caused on one occasion by the too great inquisitiveness of a visitor which interfered with the armature of one of the dynamos; but it is satisfactory to be able to chronicle (the official records will bear us out in this statement) that there were no faults whatever in the arc lighting system which were caused in any way through failure of any of the Anglo-American Brush Company's electrical plant and arrangements. This fact reflects the highest credit upon the company and especially upon its superintendent, Mr. H. Court, who had entire charge of the installation from the commencement to the completion and also throughout the whole term of its maintenance. The new arrangement of masts (unstayed) carrying three lamps connected by a concentric cable, which allowed of the framework being raised and lowered without interfering with the circuit, was found to have answered excellently.*

The large system of incandescent lighting, comprising nearly 4,000 lamps, was carried on throughout with very great success. The only slight interruptions which occurred to one or two of the circuits were due to hot bearings caused by some foreign matter getting in; these occurred in the Fine Arts Section, but as the lamps were arranged in alternate circuits no inconvenience was felt. On no single occasion are we aware of any interruption having occurred from any electrical cause, and with the number of circuits running this result may be considered unprecedented. The charge of the maintenance of the incandescent circuits was from the opening of the exhibition under Mr. Robert Young, of the Manchester Edison-Swan Company, whose experience in maintenance has been considerable, as he had charge for five years of the Manchester central lighting station. The charge of the incandescent system at this exhibition was no light one, for in addition to the ordinary cares of seeing that the dynamos and circuits were in proper working order, the constant work of fixing small installations was going on. The exhibitors found it very essential that their stands should be rendered more attractive by the addition of some incandescent lamps, and before the close of the exhibition as many as 878 lamps had been fixed for this purpose for the special

* This arrangement was designed by Mr. J. S. Raworth, the object being to avoid the unsightliness of loose wires hanging from the masts, and blowing about in windy weather. The cables were naturally subjected to a good deal of friction in the daily operation of lowering and raising for the purpose of trimming the lamps, but an examination after the six months' trial has shown that they are in excellent condition, and that the masts and cables can be used again without alteration. The cables were specially made for this work by Messrs. W. T. Glover and Co., Salford.

use of exhibitors. This amount shows a very large quantity of surplus power provided by the contractors.

The total number of incandescent lamps fixed throughout the exhibition was :—

Fine Art Galleries	1,620	
Old Manchester and Salford ...	600	
Palm House dining room	450	
Exhibitors	878	
Dynamo room and offices, &c. ...	50	
		3,598

or, practically, 3,600 lamps—the largest amount of incandescent lamps in any single installation in this country.

The total number of Brush arc lamps in daily work throughout the exhibition and grounds was 512, and the arrangement was found to be all that could be desired, and so satisfactory that a similar plan is to be adopted at the forthcoming International Exhibition at Glasgow.

The contract time specified for running the various lamps throughout the season was a minimum number of 600 hours. The extraordinary fine weather which prevailed throughout almost the whole of the time the exhibition was open, enabled "daylight" to be utilised more than was calculated upon. The consequence was that only in the case of Old Manchester and Salford and the dining room sections was the time exceeded. In these sections the total number of hours the lamps were working was 671 hours, whilst in the Fine Art Galleries (which closed at 9.0 p.m.) the time was only 503 hours. The arc light system was equally affected, and the total time made was 556½ hours.

It may be mentioned that the Fairy Fountain, which gave such great satisfaction and contributed to swell the number of visitors, will be removed to Glasgow, where it is to be hoped it will play an equally important part. The whole of the plant will be removed to Glasgow, with the exception of the engines which drove the dynamos; these have been acquired by a local establishment for its electric light installation which was under-powered.

We must not omit to mention the very great benefits and advantages derived from the central telephone exchange in the building belonging to the Lancashire and Cheshire Telephonic Exchange Company. The amount of business done was very large. The *local* messages that passed through the switch-room reached about 100,000, and there was, in addition, about 7,000 messages to and from persons outside Manchester and Salford. The total number of subscribers among the exhibitors was 61, and there were 25 private lines in addition. It was found that owing to the noise in the machinery department, exhibitors preferred using the message system from the call office, which was so conveniently central. Personal experience has shown that the service was throughout most efficiently performed by the company.

In concluding our notices of the electrical arrangements at this exhibition, we should be wanting in feeling were we not to recognise the important services rendered by the late Mr. Charles Moseley, who was the indefatigable chairman of the electric lighting section of the executive committee. It is not too much to say that to his zeal, perseverance, tact, and extraordinary business qualities, this section has owed, in a very large measure, the success which it has obtained. In Mr. W. A. Bryson, their electrician, the executive had fortunately secured the services of a most competent and zealous officer, in whose hands the carrying out of the work was ably performed, and to whose merits and constant attention and care the very great success of the electric lighting bears the surest and truest testimony.

Telegraphing in the Belgian Army.—Orders have been issued to the Belgian cavalry regiments to enter into a course of telegraphic instruction, and those officers and men selected for this duty will serve for two hours three times a week at the various railway station offices in garrison towns.

SIMPLE PROOF OF THE LAW OF THE SECOHMMETER.

By JOHN N. COOPER, Student Soc.T.E. and E.

LET there be any network of conductors, and in one of the branches of this network suppose a battery to be placed, and consider one of the branches, S, in which a current, c^1, due to this battery is flowing, and some other branch, G, in which a galvanometer has been placed, the resistances of the branches being respectively s and g; and suppose no current to flow through the galvanometer.

Now if s be increased by an amount, σ, then we know that a current will be set up in G proportional to the E.M.F., $c^1\,\sigma$, this E.M.F. acting in the branch, S, and the current through the galvanometer will be $\frac{c^1\,\sigma}{R}$ if R is what Mr. Sumpner indicates by R_{sg}, namely, the resistance between the branches, S and G.

Now take the case of the Wheatstone bridge connected with the secohmmeter.

Suppose that the battery circuit is made T seconds before the galvanometer is short circuited, then if there is no self-induction in any branch, and if branch S has a resistance, σ, greater than the value, s, which balances the bridge, that is when no current passes through the galvanometer, then the effect of σ is to produce a current, $\frac{c^1\,\sigma}{R}$, in the galvanometer during the time, T.

But if instead of an added resistance to the branch, S, there is a self-induction, L, in that branch, it is as if there were a negative E.M.F. acting of the value $L\frac{dC}{dt}$, and if the time is sufficient the current, c, in this branch increases from 0 to c^1.

The current at any instant through the galvanometer is, therefore, $\frac{L}{R}\cdot\frac{dC}{dt}$, and the total quantity of electricity passing through the galvanometer is

$$\int_0^T \frac{L}{R}\cdot\frac{dC}{dt}\cdot dt,$$

or, $\frac{L}{R}\cdot C^1$; and the average current is $\frac{1}{T}\cdot\frac{L}{R}\cdot c^1$.

If, then, this average current, which is produced owing to there being self-induction in the branch, is to be equal in its effects to the steady current which we have during the same time when the branch has an increased resistance, σ, but no self-induction

$$\frac{1}{T}\cdot\frac{L}{R}\cdot C^1 = \frac{c^1\cdot\sigma}{R},$$

or $L = \sigma\,T$.

It may be inferred from this proof that when a negative, σ, and a positive, L, exist together in the branch, and $L = \sigma\,T$, we must have a null method. Such an inference, although it may probably have been made by Professors Ayrton and Perry and so have led to the invention of the secohmmeter, is only warranted on the assumption that L and σ are very small and T many times greater than the time required for the current to rise to its steady value. So that this easy proof of the law, $L = \sigma\,T$, when put before students, ought to be supplemented by the exact proof given by the authors in their paper read before the Soc. of Tel. Eng. and Elec. on April 28th, 1887, on the secohmmeter.

INTENSITY AND CONSUMPTION OF THE ORDINARY SOURCES OF LIGHT.

By C. HEIM, of Hanover.

THE photometric measurement of certain lamps which were handed over in December last for examination to the Elektrotechnical Institute of the High School here has induced me to undertake similar determinations with the sources of light most generally used at present. By the publication of my results I believe I shall meet a demand, since there scarcely exists a compara-

tive survey of the performances of the principal sources of light obtained by the same observer and with the same apparatus.

For these measurements there has been used the photometric apparatus of the above-named institute, which is described in the *Elektrotech. Zeitschrift*, Vol. VII. (1886), p. 390. As the unit of light the the English normal candle with a flame of the height of 45 millimetres was employed. The comparison was made at this height only since the method much used in gas works, of making during 10—15 minutes a considerable number of determinations with different heights of flames, and taking the mean of these values, gives a somewhat deviating result.

Von Hefner-Alteneck's light-unit is certainly rather more convenient than the normal candle for use in technical measurements, but a great number of comparisons of these two unit-flames would have been necessary. With careful treatment 4 to 6 adjustments of the photometer screen can be undertaken twice in 10 minutes with the English normal candle.

As comparative sources of light there were used, according to the example of Krüss, petroleum lamps of different size, the constancy of which, on proper treatment, leaves nothing to be desired. If an ordinary Argand burner, after lighting, is screwed up so slowly that the normal strength of light is reached in a quarter of an hour, and it is then allowed to burn for another quarter of an hour, the strength of the light does not vary more during the next hour than at most 2 per cent. But an hour is fully sufficient for undertaking a sufficient number of determinations with the source of light in question.

With the length of the photometer tables (twice 6 metres) it was possible in almost all cases to select the distances so that the error springing from the special extent of the sources of light fell below 1 per cent.

For determining the strength of light at different angles there was used a Krüss mirror. For sources of light of a very large surface of the luminous portion the surface of this mirror was not sufficient, and a second mirror of 30 cm. in diameter was fixed upon it. The absorption of both mirrors was found by numerous measurements as 10·1 or 31·0 per cent.

As sources of light of very different colours were examined I made two experiments to determine if the amount of the absorption of a mirror is the same for different kinds of light. On one occasion the determination of the absorption was effected in the ordinary manner by means of two petroleum lamps of approximately equal luminosity, only there was placed on each side before the photometer screen a glass trough with plane parallel sides each containing a blue liquid. In the second experiment I compared a petroleum lamp of 20 or 25 normal candle-power with a strongly "overburnt" glow lamp. I used an 8-candle Edison lamp, and increased the tension so much that the lamp gave out 25—30 candles. Its light then contained so many blue and violet rays that in colour it closely approached the arc lamp.

On adjustment with and without a mirror the tension as measured with the torsion galvanometer was brought each time to the same amount. As the glow lamp burnt each time only for a few minutes, it might be assumed that the strength of the light had not varied. At the end of the experiment the lamp glass was not perceptibly smoked.

The values obtained from both experiments for the coefficient of absorption of the mirror did not deviate from the mean value obtained by means of an ordinary petroleum light more than did the single values which had yielded this mean.

Hence in examining sources of light of so different colour as arc lights and petroleum lamps the same value may be used without hesitation for the absorption of the mirror. If γ signifies this coefficient of absorption, L the true strength of light of the source to be measured and L′ the strength of light (too small) as found by the use of the mirror, it may be easily shown that

$$L = \frac{L'}{1-\gamma}.$$

The greater part of the sources of light examined has been measured only in two directions, horizontally and at an angle of 45° to the horizontal, downwards. The values thus obtained suffice for forming an opinion as to the efficacy of the source of light in question; measurements at other angles would have considerably protracted the experiments.

Every source of light has been examined several times (generally three times) and on different days, so that there were obtained several values independent of each other. The means from these values are given in the following tables. It was assumed that within the limits in which the single values fall, the strength of light varies proportionally to the consumption. During the time of a measurement there was made by each of the operators a considerable number of observations, as many as 40—50, in case of decidedly fluctuating sources of light. In this manner were obtained mean values which agreed well even when the source of light was very inconstant, and was of a very different colour from the comparison light.

The comparison with the normal candle took place at the beginning and at the end of each experiment. If two comparison lamps were used in measuring powerful sources of light, they were compared with each other every quarter of an hour.

Details on the arrangement of the experiments, as well as on the manner of measuring the consumption in the single cases, will be found below in the respective tables.

The greatest possible care was taken to maintain pure air in the photometer room during the experiments.

Herr W. Fricke, a student of electricity, has had the kindness to take part in the measurements, for which I here express my thanks. Most of the following numbers represent, consequently, the mean values from the observations of two equivalent observers. As is well known, in photometric determinations by different persons there always appears an individual difference, which was here found to be the case. The determinations always differed from each other in a corresponding manner. But the difference in the results for all sources of light of a constant, or only slightly variable strength, amount to less than one per cent.

Petroleum Lamps.

The combustible used, where not otherwise stated, was the refined petroleum known as "Imperial petroleum" (Kaiser-oel), of spec. gravity 0·796 at 18° Centigrade. The consumption of oil was determined by weighing the lamp before and after the experiment and noting the time. Between the two weighings the lamp burnt with the full strength of light, as measured.

Only the figures in the last column but one, which express the proportion $\frac{\text{hourly consumption}}{\text{strength of light}}$ are characteristic of the several lamps.

TABLE I.

Name.	Diameter of burner.	Angle with horizon.	Strength in normal candles.	Hourly consumption of oil.	Hourly consumption and strength of light.	Remarks.
				grms.	grms.	
Ordinary round burner	25 mm.	0°	16·1	54·2	3·37	
Do.	...	45°	12·3	53·6	4·36	
Round burner with a plate (fig 1), small...	30	0°	19·2	63·4	3·30	
Do.	...	45°	11·1	61·1	5·51	
Round burner with plate, large	62	0°	67·3	229	3·40	
Do.	...	45°	33·9	228	6·70	
Kosmos Vulcan burner (fig. 2)	30	0°	22·9	84·9	3·70	American petroleum.
Do.	...	45°	17·8	85·5	4·80	
Do.	...	0°	22·8	81·7	3·59	Imperial oil.

The figures in the above table justify the following conclusions: on measuring the strength of light in the horizontal direction, the performance of all the petroleum lamps examined is about the same, notwithstanding the difference of construction. An increase of size does *not* increase the yield of light. If measured at 45°, the strength of light decreases the more, the greater the diameter of the burner. This is mainly due to the circumstance that in small lamps the flame extends more in height and less in breadth, whilst the larger types have a broader and relatively lower flame. In the latter, therefore, a larger portion of the flame is covered by the burner than in the small lamps.

The most favourable performance is that of the ordinary round burner with an elongated flame (height of flame 70—80 mm.), if we consider that at 45° the consumption of oil per hour and per normal candle is only 29 per cent. greater than in a horizontal direction, whilst the largest of the burners measured consumed at 45° double as much oil per hour-candle as in the horizontal direction. The "Cosmos Vulcan burner" yields, next to the common round burner, the best distribution of light owing to the saucer-like expansion of the flame. The use of refined petroleum does not improve the performance of the lamp to an appreciable extent.

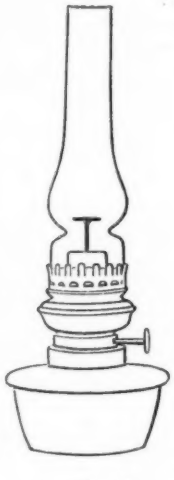


FIG. 1.

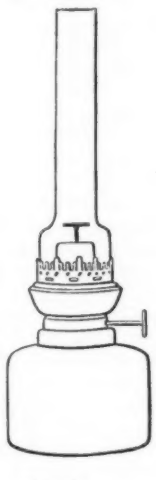


FIG. 2.

The following small table shows how much the useful effect of a petroleum lamp decreases if the flame is not regulated to its full height. The experiments were made with the above named common round burner.

TABLE I*a*.

Angle.	Strength of Light.	Hourly consumption.	Consumption per candle hour.
0	18·9	58·4	3·09
0	16·8	56·0	3·33
0	15·0	54·8	3·65
0	12·7	50·7	3·99

By the use of suitable reflectors the action of petroleum burners—as of any source of light—can, of course, be considerably increased in any given direction.

Hitherto there exists no lamp which, by means of an increase of the temperature of the flame and a practical arrangement of the essential parts, utilises petroleum even approximately as well as it is done with gas in modern gas burners.

Gas Burners.

The determination of the gas consumed was effected by means of standardised "wet metres" of a suitable size. During the experiments the consumption was read off every quarter of an hour, noting the time.

The regenerative burners examined were let burn for half-an-hour at full strength before beginning the measurement, and the smaller burners were let burn amply long enough to heat the cylinder and the other parts. The experiments were made in the forenoon, to avoid the risk of a sudden alteration in the pressure of the gas.

With the regenerative burners the flow of gas was regulated so that the flame had the prescribed height. The Argand and flat burners burnt at a mean height. Care was taken for the speedy removal of the products of combustion. Exactly above the light under examination there was the opening of a ventilator shaft.

The results refer to the gas of the Hanover works, which has about the normal composition customary in Germany and which is considered to vary little.

TABLE II.

Name.	Angle with horizon.	Strength in normal candles.	Hourly consumption. Cubic metres.	Consumption per candle hour (litres).	Remarks.
Flat burner	0°	16·9	0·251	14·8	Middle size called "6 cubic feet burner."
Do.	45°	17·2	0·256	14·9	
Argand	0°	21·9	0·239	10·9	
Do.	45°	19·4	0·241	12·4	
Auer's gas glow light	0°	14·4	0·0951	6·60	Received from Pintsch, of Berlin, as the newest type.
Do.	45°	10·5	0·1037	9·88	
Siemens regenerative burner No. 3 ...	0°	65·3	0·460	7·05	
Do.	45°	46·9	0·456	9·75	
Siemens do. No. 1 ...	0°	222	1·621	7·30	
Do.	30°	162	1·614	9·96	
Do.	45°	132	1·604	12·2	
Wenham burner No. 2	0°	28·4	0·249	8·77	
Do.	45°	44·5	0·257	5·77	
Do.	90°	45·8	0·256	5·58	
Wenham burner No. 4	0°	99	0·685	6·92	
Do.	25°	152	0·686	4·51	
Do.	45°	170	0·677	3·98	
Do.	65°	200	0·685	3·42	
Do.	90°	202	0·671	3·33	

The plane of the flat burner was set during the measurement, perpendicularly to the axis of the photometer. As it is well known, about the same strength of light is obtained when measured in the direction of the plane of the flame. I have not thought it necessary to repeat the demonstration of this fact.

The equality of the strength of light under different angles is explained by the circumstance that portions of the luminous region are concealed by the burner only if it inclines very strongly to the horison.

It is known that the luminous value of gas can be considerably increased by elevating the temperature of combustion and by improvements in the construction of the burner. A glance at the figures of the last column but one shows the performance of the different burners. The argand exceeds the flat burner, and is, in turn, surpassed by the Siemens regenerative burner. As for the latter, Table II. shows that here also the performance is not improved by an increase in the size of the type. At 45° the small burner acts more advantageously than the large one, on account of the more elongated shape of its flame. In the broad type, No. 1, the burner cap at the above-named angle covers a larger part of the flame. The unfavourable distribution of light (maximum in a horizontal direction) is common to the Siemens and the Argand burners.

In this respect the Wenham lamp—introduced about a year ago—acts more favourably. It has the greatest strength of light at 90°, that is, perpendicularly downwards, and as far as 45° it suffers no important decrease. Hence it is especially adapted for lighting up in-door space. The Wenham burner also utilises gas at present most thoroughly, as appears on comparing the performance of the several burners at 45°. We obtain with it,

for the same consumption of gas, $3\frac{1}{2}$ times more light than with flat burners. The larger type shows also at all angles a better performance than the small one, doubtless in consequence of a somewhat higher temperature of the flame.

The luminous value of gas may be also increased by Auer's incandescent body as compared with the performance of the Argand and flat burner.

(*To be continued.*)

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 279.)

As the writer has been compelled to break off these articles for some weeks it will be as well to remind the reader of the main points of the last article. It would be too much to ask the most gentle reader to turn up a back number of the paper to see what one had said.

The important law that incandescent lamp carbons at the same temperature give light of the same colour, and run at the same efficiency was explained; and it was pointed out that Mr. Bottomley's experiments were insufficient to overthrow this theory at present.

It was also explained that the term "candle-power," as generally used, means nothing; and the candle-power of a lamp was more strictly defined as the emission in a horizontal direction of a cylindrical carbon of the same surface held vertically.

This way of taking the candle-power has the advantage of being simple, as most carbons are of circular section and horseshoe or double loop form. If a horseshoe carbon is held flatways towards the photometer it gives out the same light in that direction as it would if it were stretched out into a vertical cylinder. The same holds true with a looped carbon, if the carbon is so thin that the part in front does not sensibly shade a part behind.

It is not necessary to go deeply into the question of photometry of incandescent lamps here, as most engineers do not want to test very large numbers of lamps rapidly and at the same time accurately.

The most convenient form of photometer is the Bunsen grease spot. Candles are not used in practice as light standards. The Methven screen or the Harcourt lamp is convenient. As the writer has had more experience with the Methven screen it will be described. It consists of a Sugg's referee burner, with a screen between it and the grease spot, the screen being pierced with a small rectangular hole. Photometers with Methven screens are made by Wright, of Westminster. In these the standard burner is on a moving carriage. This arrangement is faulty: the lamp ought to move while the standard remains fixed. The Methven standard is wrong when the screen is close to the grease spot. Before using such a photometer it is necessary to calibrate the standard. The first thing to do is to mark off the scale for the lamp. If it is desired to measure lamps up to, say, 50 candles, the far end of the scale is marked 50, and the scale is divided up, the numbers marked varying as the square of the distance from the grease spot. This can be done rapidly with the help of a slide rule.

The pentane, or other standard lamp, is then placed on the mark corresponding to the light it gives. The Methven screen is then moved till it exactly balances the standard, and is fixed at that point. If any other standard is at hand, the Referee's burner of the Methven lamp may be used, especially if the photometer is in London, where the gas is very uniform in illuminating power. The screen is removed and the Sugg burner placed at a distance from the grease spot equal to that of the 16-candle mark on the other scale. The gas is turned up to the right height, and another gas jet of any sort is placed on the other scale and moved till it balances the standard 16-candle burner. The screen is now replaced, and the burner and screen are moved up till they balance the jet, and fixed there. Of course it is not necessary to make the screen exactly accurate to the Methven sizes if it is calibrated in this way. Any argand burner with a screen of the same sort as Methven's may be used and compared with a standard. These methods of calibration are accurate enough for ordinary work.

In installation work, what is wanted is to be able to run the lamps as bright as possible without breaking them, so that they run at the highest efficiency compatible with economy in replacing. To get the best result it is obviously necessary that all the lamps should run equally bright, that is to say, at the same efficiency and same temperature. To make sure that the lamps all run at the same temperature they should be tested at the same efficiency, that is, the same candles per watt. Thus, unless the efficiency is stated, such an expression as 85 volt lamp means nothing; as a lamp might be run at any electromotive forces from 80 to 90, but would then run at different efficiencies. What are known as high efficiency lamps are simply small lamps tested bright; a similar lamp tested at a low electromotive force would be sold as a low efficiency lamp. After being sold the lamps might be run at electromotive forces different from those marked, and the so-called low efficiency lamp might be run brighter than the other, and would then really give a higher efficiency without getting credit for it. The efficiency is not a property inherent in a lamp, as many people seem to think, it depends only on the temperature at which the lamp happens to be running.

The photometer is, of course, provided with adjustable resistances, such as the mho switches already described; or secondary batteries may be used with switches for varying the number, as described for use in calibrating voltmeters. In incandescent lamp manufacture a wattmeter is used as well as a voltmeter and ammeter, as it saves a great deal of time; but for testing lamps, for instance, at an important central station the work can be done with only a voltmeter and an ammeter. The voltmeter should be put in shunt to the ammeter and lamp, not to the lamp alone, and the ammeter and the leads from it to the lamp should be without appreciable resistance. If their resistance is appreciable, the writer's method of compensation may be used. Part of the current circuit is wound backwards round the voltmeter till there is no deflection when the lamp holder is short circuited, the voltmeter will then read the electromotive force on the lamp, though it is not really on its terminals. A fine wire in shunt to the ammeter is often convenient for winding these backward turns.

Before testing a lamp it must be decided what efficiency it is to be tested at. The writer generally takes ·3-C.P.W. as the normal efficiency; some, however, prefer the lower efficiency of ·25-C.P.W., or taking it backwards, 4 watts per candle. The lamp is put at the expected candle-power, say 16, and run up by the mho switch till it gives 16 candles. The electromotive force and current are taken and their product multiplied by ·3. If this gives 16 candles the lamp is running at ·3-C.P.W., and may be labelled with the volts and ampères read. If too bright or too dull, a new reading is taken and a new calculation made, and so on. A slide rule is convenient to make these calculations, but even then the process is very slow and tedious. The writer has designed a photometer scale which saves a great deal of labour. The index on the lamp-holder not only passes over the candle-power marks, but stretches across a broad scale. This is marked out with parallel lines running along it marked in volts. Thus for measuring from 40 to 120 volts there are 60 lines marked in volts. The tens and fives are made thick to be more easily seen. Curves, really parabolic, are drawn to represent ampères cutting the volt lines at points such that all the intersections opposite any candle-power correspond to volt and ampère lines whose product is ·3 of the candle-power. Thus, suppose the

lamp, as before, runs at 16 candles; the voltmeter is read and the ampère line intersecting the corresponding line under the lamp index is noted. Suppose it is 1·4 ampères, if an ammeter shows, say, 1·3 ampères, the lamp is running too bright, and so on. This method, of course, requires no calculations.

Lamps supplied by the makers to run together need not necessarily give the same light or take the same current, but it is absolutely necessary for good work that they take the same electromotive force at the same efficiency, so that they will all run at the same temperature.

If a lamp has a flat carbon a correction must be made. This is done best by opening one lamp and carefully measuring the carbon. The ratio of the surface exposed to the photometer to the surface that would be exposed were the carbon cylindrical is then calculated, and the Methven screen is moved forward a little to make the readings come right. The Methven screen instead of being absolutely fixed is made to move over a short scale. This scale is used for corrections for flat carbons, and for testing at efficiencies other than those for which the other side of the photometer has been graduated.

The photometer can then be used for testing at any desired efficiency without the calculating scale having to be altered.

Testing lamps to see that they all run at the same temperature is not enough for installation purposes; the engineer also wants to know which lamps are best, that is to say, which lamps will last longest at a given efficiency. People talk of the life of lamps in much the same way as they talk of their efficiency. The life of the lamp obviously depends on the way it is run and of the durability of the carbon. A good lamp on an installation where the electromotive force varies considerably on each side of the normal will not last as long as a bad lamp run on a circuit on which the electromotive force is kept constant.

No incandescent life tests of any value have yet been published. Tables giving lives, taken with considerable care and trouble have appeared, but in all cases there have been slips and omissions that render the data valueless. Sometimes the lamps have been run at different efficiences; mistakes have nearly always been made in taking the candle-power, and the electromotive force has not been kept absolutely constant. We thus do not yet know what is the best efficiency at which to run well-made lamps.

It is not difficult to determine which of two or three types of lamp is the best. If the lamps are for parallel work, as is generally the case, two or more specimens are carefully tested at the same efficiency. If the electromotive forces required are not the same, resistance is put in series with those of low electromotive force till they can all be run together. They are then run in parallel and their lives noted. As this test may take a long time, and it may be inconvenient to get enough electromotive force to overrun them, it is a good plan to order a few lamps of slightly lower electromotive force than those in use on the installation.

In many cases it will be found that instead of breaking a lamp increases in resistance, thus protecting itself. A lamp that has increased in resistance may be regarded as broken, because such lamps are practically useless. If some of the lamps on an installation run dull they are practically useless, as it would pay better to replace them than to continue to run them. If many run dull, however, the chances are that the engineer will increase the electromotive force of the circuit to suit the dull lamps, so that the bright lamps break. If new lamps are ordered to replace those of the original electromotive force, they will be over-run. If lamps are ordered of higher electromotive force, the electromotive force needed on the installation gradually rises till the engine can go no faster. The result is that all the lamps on the installation are run dull, and therefore expensively. This is the reason why the lamps on old installations are generally run so dull; all the bright lamps have died out, and those in use are run dull.

A lamp that blackens may also be regarded as useless. People do not seem to realise what a little light a blackened lamp gives. It is strange that many engineers will buy what are called high efficiency lamps, and will then run them like hot hair pins, or blacken them till they give out something like two candles, still thinking they are getting high efficiency.

ELECTRIC PUMPING IN COLLIERIES.*

BEFORE electricity is adopted by practical mining engineers, they must be convinced that it can compete economically with other modes of transmitting energy —modes which are well known and generally applied.

What percentage of indicated steam power applied to the generating electric machine is given off ultimately as available energy for mechanical work? How does it compare as to cost? Under what circumstances would its application be economical? If leading main questions such as these can be plainly and satisfactorily answered, practical men will not be long in arriving at a favourable opinion and acting upon it.

The application of electricity to underground pumping has enabled the writer to tabulate some particulars which he believes will go a long way toward satisfying enquirers that this is a method of transmitting energy capable of wide and economical adaptation.

Some four years ago (Vol. 13, No. 5) Mr. W. B. Brain described to this institute in a short paper a small electric pumping plant at Trafalgar Colliery, Forest of Dean, doing the work of about 1½ H.P. This, the writer believes, was the first attempt ever made at pumping in mines by electricity. It has continued working satisfactorily up to the present time. A similar set using about 2½ H.P. has been working in another part of the mine, some 800 yards from surface for the past one and a-half years. Both are doing excellent service removing small quantities of water from remote parts of abandoned workings, which for the safe working of the colliery must be kept free from accumulations of water. It may be well to say that the majority of the collieries in the Forest of Dean have their shafts sunk on the "rise" of the taking, and the coal is won by "dipples," or engine planes, going full dip with the strata. The outcrop is riddled with old abandoned workings. These receive a great quantity of surface water, which finds its way down the slope of the strata to the deeper workings now in operation. The two electric pumps above referred to intercept some of this water on its downward course. The electrical pumping plant which the writer purposes describing in this paper has been put in to deal with the main come of water in the deep workings of the Trafalgar Colliery. The pump and motor are placed a distance of about 1,650 yards from the bottom of the shafts, and the water has to be forced by this pump a vertical height of 300 feet to the pit bottom. This water had, previous to May last, been coped with by one of Hathorn Davey's water power pumps working in conjunction with a 7-inch double plunger Manchester Pearn pump with 10 inch steam cylinders and 14 inch stroke, the steam being obtained from the tubular boilers fixed underground.

The present pump—a double 9-inch plunger with 10-inch stroke—has been specially designed by the Lilleshall Iron Company, Limited, from sketches furnished by the writer, and is fitted with spur gearing running six to one. It is driven by a leather link belt, running off a 5-feet 4-inch pulley keyed on the same shaft as the spur pinion to a 14-inch pulley on motor shaft. Thus when the motor is running at about 650 revolutions per minute, the pump is making 25 revolutions. The motor supplied by Elwell-Parker, Limited, of Wolverhampton, is described as one of their 12-inch machines—maximum speed about 650 revolutions per minute, output about 13,000 watts. The electric cur-

* Read by Frank Brain before the South Wales Society of Engineers, Cardiff, 24th November, 1887.

rent is conveyed to it by a copper cable 2,000 yards long, 19/16 wires, wrapped in compounded tape, which was supplied by the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, Silvertown. This is enclosed in wooden boxes in the pit shaft only. It is supported upon earthenware insulators placed at intervals of about ten yards along the side of the underground roads. The return cable is an old iron pit rope about four inches in circumference, stapled to the road posts. The generator, placed on surface near the top of the shaft, is another of Elwell-Parker's 12-inch machines. Its maximum speed is about 950, and output 17,000 watts. A belt communicates the power from a 12-inch pulley on the generator to a 5-feet 11-inch pulley attached to the crank shaft of an engine. The steam engine has a single 16-inch cylinder with 12-inch stroke, and works with about 35 lbs. steam pressure. It is an old marine engine, picked up some time since at an auction sale, and is not what one would purchase new for the work. It indicated, running empty, a loss of 5 H.P., the valves and piston being both the worse for wear. In the same engine-house is another engine which supplies the power for the two small electric pumps previously referred to. The steam for both is obtained from the range of colliery boilers near. A small insulated copper wire connected to a battery of eight No. 3 Leclanché cells connects the engine-house with the pump-house underground, and through this is registered upon a belt in the former each stroke of the pump. It is also used as a telephone line, so that a conversation can at any time be carried on between the engine man on surface and the man in charge of the pump underground. The two smaller pumps are locked up, with no one in charge, only being visited occasionally; but with this larger one some one is thought necessary, although there is rarely anything more to be done than oil the machinery, adjust the machine brushes, and turn on the electricity. Near the engine the necessary electrical instruments—a voltmeter and an ammeter—are placed, by which the engine-man knows the machines and cables are working properly. A magnetic cut-out is also placed in the main circuit, so that should the current through any unforeseen cause increase it automatically breaks the circuit, thus preventing the flow of electricity through the cables. The maximum speed at which the pump has been driven is 25 strokes (114 gallons) per minute. The observations taken at the time were :—

Indicated H.P. of steam engine ...	29·49
Speed of generator	900
Volts at terminals of generator ...	320
Ampères ditto	43
Speed of motor	650
Volts at terminals of motor ...	260
Ampères ditto	43
Actual H.P. of water lifted	10·36

The first diagram exhibited is prepared from the above figures, and shows the total loss of power (19·13 H.P.) to be apportioned thus :—

Loss in engine	6·49 H.P.	or 22	per cent.
Loss in generator	4·56 „	„ 16	„
Loss in line	3·45 „	„ 11	„
Loss in motor	3·00 „	„ 10	„
Loss in pump	1·63 „	„ 6	„
	19·13 H.P.	or 65	per cent.

The actual proportion of power given off by steam engine used to lift water is, therefore, 35 per cent. A second diagram shows the percentage of useful effect extracted from the power received at each stage, together with the percentage of loss, thus—horse-power indicated by steam engine, 29·49.

	H.P.		Per cent.	Useful effect. Per cent.
Received by generator,	23·00.	Loss in steam engine,	22 ...	78
„ „ cables ...	18·44.	„ „ generators ...	20 ...	80
„ „ motor ...	14·99.	„ „ cables ...	20 ...	80
„ „ pump ...	11·99.	„ „ motor ...	20 ...	80
„ „ water ...	10·36.	„ „ pump ...	14 ...	86

A third diagram shows the loss between the power given off at the belt of the steam engine and the actual work done, thus—horse-power given off to generator, 23·00

	H.P.		Per cent
Loss in generator	4·56	or	20
„ cables	3·45	„	15
„ motor	3·00	„	13
„ pump	1·63	„	7
			55

The proportion of power given off by belt used to lift water is, therefore, 45 per cent. As to cost, the writer has been to considerable pains to verify the following figures, knowing that with business men this is the crucial test. The following is a summary of the first cost of the plant—

	£	s.	d.
Two electric machines	310	0	0
Insulated copper lead	138	0	0
Return wire--iron rope	25	0	0
Signal wire	10	0	0
Insulators	6	0	0
Steam engine (estimate) ...	140	0	0
Fixing and sundries	15	0	0
	£644	0	0

The pump (£130) and pipes are not added to the above, seeing that this item of cost would of necessity be part of any set of plant, and it would therefore be an item of cost common to all systems.

Detailed cost of pumping 114 gallons per minute with above machinery through 1,300 yards 7-inch pipes—main rising 300 feet—one week's pumping, 22 hours per day.

	£	s.	d.
Engineers (half time)	1	8	0
Man underground (full time)	2	9	0
Small coal consumed, say 36 tons at 1s....	1	16	0
Oil, waste and sundries	0	7	0
Say 15 per cent.	1	17	0
	£7	17	0

Cost per horse-power on water raised, ·02 of a penny; cost per 1,000 gallons of water raised, 1·80 pence.

The come of water in the deep workings of the colliery has been much below the average during the past dry autumn. The pump has therefore been usually worked at about 64 gallons per minute. The results, of course, not being so good, are as follows :—Proportion of power generated used to lift water, 32 per cent; cost per horse-power in water raised, 0·3 of a penny; cost per 1,000 gallons of water raised, 3 pence.

When opportunity offers, and the hold of water is pumped out, this plant is utilised to assist in maintaining the ventilation. Some 1,200 yards underground a small fan, passing some 10,000 cubic feet of air per minute, is placed in a return air way. A branch connection is made from the main cable to a dynamo which drives the fan by belt connection. The cost of maintaining the present plant, compared with that it has supplanted, shows an economy of about £470 per annum. This the writer does not, however, rely upon as a fair comparison of cost, seeing that the former plant had to be worked under most disadvantageous circumstances.

The whole of this plant was supplied by the various makers to specification, and was put in by the colliery mechanics without any outside assistance. It commenced working without a single hitch, and has worked continuously since the end of May last with but one accident. This, strictly speaking, cannot be spoken of as an accident. A couple of weeks ago we found much more current was being taken to do the ordinary work than usual, and on examination traced the cause to the cable in the pit shaft.

Here, as already explained, the cables which are not highly insulated are carried in wooden troughs. The late continuous heavy rains had very much increased the feeders of water in the shaft, and this water, find-

ing its way into the boxes saturated the cable, causing a great escape of electricity. A lead covered cable was substituted for the ordinary one, and the difficulty was thus completely overcome.

The cable was a matter of some anxiety when the plant was being provided, as the writer feared that falls which cannot be prevented on underground roads would be constantly damaging it and causing delays.

In practice this has never been yet found to occur. With the one line indestructible (as the iron pit rope practically is), the other, should it be damaged, can quickly and easily be repaired or replaced with new, so that this, one of the most formidable of the anticipated difficulties has proved quite illusory. The plan which has been adopted of supporting the cable upon earthenware insulators has proved a good one, more perfect insulation, a very important factor, being obtained. The repairs necessary to the side timber of the roads along which the cables are supended is also facilitated.

The commutators are the principal electrical wearing parts, and with care these will run a considerable time. In this instance, after five months' work, the wear shown is only about one-sixteenth of an inch, although there is an inch thickness of copper to be worn away before it is necessary to have a new one. With a spare armature kept in hand, which costs about one-third the price of a machine, no accident can happen which the colliery mechanics cannot repair, and that with little delay, everything being simple in construction and easily to be got at.

It is an advantage which colliery managers will appreciate to concentrate work and have it under personal supervision. Given sufficient engine power, any reasonable number of generators can be driven in one engine house on surface, delivering power to distant places underground at various points of the compass. These dynamos would require but one man to attend to them, and the work done could with ease be supervised. The steam, too, can be generated at least possible cost under such circumstances and with the work divided between two or three engines, a breakdown with either, should it occur, need not cause any delay. It is especially noticeable that this plant can be put down economically and with great despatch. With pipes carrying steam, compressed air, or water, it is often necessary to place them in ditches specially made at considerable expense along the sides of the underground roads so as to protect them from injury and keep them out of the way.

The outlay in pipes is also great, more especially when the route is devious, and if the roads are at all given to "puck," these are constantly being broken.

With electric cables none of these difficulties occur. No matter how intricate the route may be, a thousand or two thousand yards can be put to work in as many hours as it would require weeks to put in pipes. Given a pump with the necessary suction and delivery pipes fixed a mile underground, with steam-power available on surface, and it would be practicable to have that pump in work in less than a week, an impossibility with any other method.

A few brief extracts from papers already published, comparing the cost of electricity with the power derived from steam, compressed air or hydraulics, may be interesting.

The following is given by Prof. Schulz ("Proc. Inst. Civil Engineers," Vol. 78, p. 67, and "Transac. N. of Eng. Institute of Engineers," Vol. 34, p. 5). Total cost of underground haulage by locomotive :—

	Per ton in pence.
Steam engine	1·0
Electric engine	1·54
Compressed air engine	2·06

Total cost of various systems of underground haulage :—

	Per ton in pence.
Endless chain	0·98
Rope and counter rope	1·26
Electric locomotive	1·54
Rope and tail rope	1·89
Endless rope	2·83

A comparison between electric transmission and mechanical methods was published in Berlin, in 1883, by A. Beringer, and awarded a prize by the Electrotechnical Society there.

A *resumé* of it appears in the "Revue Universelle des Mines" (ser 2 tome 15, p. 522). The following brief extract may be of interest :—

Comparison of cost on 10 effective H.P. hours transmitted 1,093 yards :—

By cables	1·77d.	per effective H.P. per hour.
„ electricity ...	2·21d.	„ „ „ „
„ hydraulics ...	2·90d.	„ „ „ „
„ compressed air	2·98d.	„ „ „ „

Comparison of cost on 50 effective H.P. hours transmitted same distance :—

By cables	1·35d.	per effective H.P. per hour.
„ hydraulics ...	1·87d.	„ „ „ „
„ electricity ...	2·07d.	„ „ „ „
„ compressed air	2·27d.	„ „ „ „

Comparison of cost on 10 effective H.P. hours transmitted 5,465 yards :—

By electricity ...	2·64d.	per effective H.P. per hour.
„ compressed air	4·66d.	„ „ „ „
„ cables	4·69d.	„ „ „ „
„ hydraulics ...	5·29d.	„ „ „ „

Comparison of cost on 50 effective H.P. per hour transmitted 5,465 yards :—

By electricity ...	2·37d.	per effective H.P. per hour.
„ cables	2·65d.	„ „ „ „
„ compressed air	2·99d.	„ „ „ „
„ hydraulics ...	3·02d.	„ „ „ „

Steam was the prime motor used in each instance. From the above figures it is to be inferred that for distances of about 1,000 yards cable transmission costs least, but that in longer distances electricity takes the lead and maintains it against all other systems. The cost per effective H.P. per hour of the electrical pumping plant herein described is found by the figures as to cost already given, to be 1·18d. It is obvious that a future is before electricity in the transmission of power. For coal cutting, it affords a ready means of distributing power; for hauling engines, which can either be stationary or run to various parts of the colliery on prepared tracks—as well as in pumping—this new motive power must take a place, and that no despicable one, in the future of colliery work.

COMPOUND-WINDING DYNAMOS: BRUSH v. CROMPTON.

By S. ALFRED VARLEY.

THAT the above case should have terminated in the way announced in your Journal must, I am sure, be a matter of deep regret to all those interested in the development of the electrical industry, and who well know the blighting and baneful consequences to a growing industry when it becomes absorbed by a monopoly.

With my special knowledge I find it difficult to understand how it is the defendant in the late case, after carrying it so far, should not have had faith and courage enough to actually fight, for I have no hesitation in saying there was a complete defence, and in saying so I am not simply expressing my own individual opinion, but what I know to have been the opinion also of those who have been officially consulted on the side of the defence.

It goes without saying that I myself *exceedingly* regret the termination which has been come to, for although I have no legal claims to assert, as my patent was allowed to lapse, the scientific credit and prestige which would have accrued from a successful defence, would have been of considerable value to me.

In addition to this, I also feel as an Englishman that there is a certain amount of disgrace in allowing the Americans in this country to take precedence and claim royalties for an invention neither originating with nor perfected by them.

My late connection with this case, as well as the personal interest I feel in it, had caused me to take infinite pains to study the matter at issue in all its bearings. I have read the whole of the English affidavits on both sides, and I feel confident that if those affidavits were put into the hands of an impartial jury of scientific and commercial men, and they were asked, with the assistance of those affidavits only, to decide the matter at issue, viz., whether the credit of having first described a system of compound-winding was due to myself or to Brush, they would find no difficulty in awarding it to me as having described it in my earlier invention.

As, unfortunately, no legal decision has been arrived at, I propose to try the case through the columns of your Journal, and I expect to be able to show that, whatever claims Brush may have to be considered to have described a system of compound winding in his patent of May, 1878, No. 2,003, they were anticipated and described in my earlier patent of 1876, No. 4,905.

Before I proceed to discuss the respective patents of Varley and Brush I should like briefly to refer to the former dynamo-electric case of Wilde *v.* Gramme, which resembles in some particulars that of Brush *v* Crompton.

In the case of Wilde *v.* Gramme I was informed by the solicitors for the defence that because their clients could obtain so little real assistance in this country, they were disposed to give way and come to terms with the plaintiffs. I strongly advised the solicitors to urge their clients to take a bolder course, and I offered to place my services gratuitously at their disposal. With a view to assist them I drew up a report on the whole case, which did infuse sufficient courage in the defendants to resist.

After this I drew up an opinion, and minutely analysed the patents of Wilde, and the defendants were successful in resisting the claims asserted on the part of Wilde at the first stage, and permission to disclaim was refused. The lawsuit was, however, not withdrawn, and I continued to advise, and drew up the defence. When the case was called the plaintiff abandoned the suit, paying costs.

Had I not been able to persuade the defendants in that case to resist, in all probability the owners of Wilde's patent would have been enabled to obtain a monopoly of the manufacture of *all* dynamos, and the great and very rapid developments in the design, manufacture and construction which has been effected since the date of that lawsuit would probably have been put back for a number of years.

In my opinion the electric light industry has so far allowed the Anglo-American Brush Corporation to simply walk over the course, and it seems to me to have acted most shortsightedly in doing so. It requires no prescience to foresee, after the trade has acknowledged the claims asserted by the Brush Corporation, by submitting to pay royalties, that the next step will be to apply for a prolongation of the patent on the ground that this *valuable* invention, due to the *genius* of Brush, has yielded no returns commensurate with the expenditure incurred in developing it. And who shall blame them for making such an application, seeing that in the circumstances I have mentioned, it would most probably be successful?

There is one other matter to which I think it advisable to refer before actually commencing the consideration of the Varley and Brush patents, as it demonstrates that the Americans were alive to the importance of obtaining information up to date as to what had already been done and was being accomplished in Europe.

I made the acquaintance of Mr. Frederick Churchill, of New Brunswick, Connecticut, who came over to Europe, I believe, in 1876 or 1877. He informed me that a number of American capitalists had held a meeting and had come to the conclusion that there was the prospect of a large industry arising out of the discovery of dynamo machines, and secondly, that in *this* branch of knowledge America was *far* behind both England and France. He further told me that capital had been subscribed by these Americans, and he had been commissioned to proceed to Europe to collect all the information he could. Mr. Churchill returned to America for good in 1878, but the mental strain he underwent after his return brought about his premature decease, and his widow wrote to me informing me that she considered he had been killed by electricity as much as if he had been struck by lightning.

Now, it must be remembered that the printed copy of my 1876 patent was to be purchased *ten* months *before* Brush lodged the provisional specification of his patent, in which it is claimed compound-winding was described for the first time.

It seems therefore probable that Brush read my specification before drawing up his own. Brush was undoubtedly a man of great energy and ability, who took up the subject of dynamos with the determination of carrying it through to a successful issue; but his specification bears on the face of it evidence (to anyone possessing claims to electrical knowledge) that at the time Brush drew up his 1878 specification he must have been very deficient in electrical knowledge, and his specification would seem to have been compiled from a study of previous inventions, which, owing to his want of electrical knowledge, even of an elementary character, he only very partially understood.

S. Alfred Varley's Patent of 1876, *December* 19*th*, *No.* 4,905.

The manufacture of this machine was commenced early in December, 1876, at the works of Messrs. Siebe and Gorman, before the provisional specification was lodged, and Messrs. Siebe and Gorman were joint proprietors of the patent with myself. The machine was completed and tried in the spring or summer of 1877. The progress in dynamo-electric apparatus since the date when my specification was lodged has been so rapid that it is difficult in the present day to realise the comparatively crude character of dynamo-electric accessories 10 years ago.

High mathematical talent had reported at that time that there was no prospect of economically dividing the electric light. There were no incandescence lamps in the market, and the experiments which had been tried to divide the light did not seem to be very promising.

My machine was worked with an ordinary Serrin arc lamp, and also with a French incandescence lamp consisting of a number of small carbon rods enclosed in a partially exhausted receiver, and which came into circuit one after the other.

I had two objects chiefly in view when designing this dynamo. The first was to develop electrical energy of high potential so as to obtain a greater output relatively to the size of the machine than had hitherto been accomplished, and the second was to make the machine automatically self-regulating. It was an advantage evident to anyone that a machine which developed force should be self-regulating, and the desirability of obtaining a uniform potential under changes of resistance had been forcibly brought home to me during the time I was in the service of the British Telegraph Manufactory, viz., between June, 1874, and February, 1876.

The British Telegraph Manufactory possessed the sole right to manufacture the Gramme machine in this country, and I took part in the numerous experiments which were made by the late Mr. Werdermann, the introducer of the Gramme machine into England, and the late Mr. Robert Sabine, the managing director of

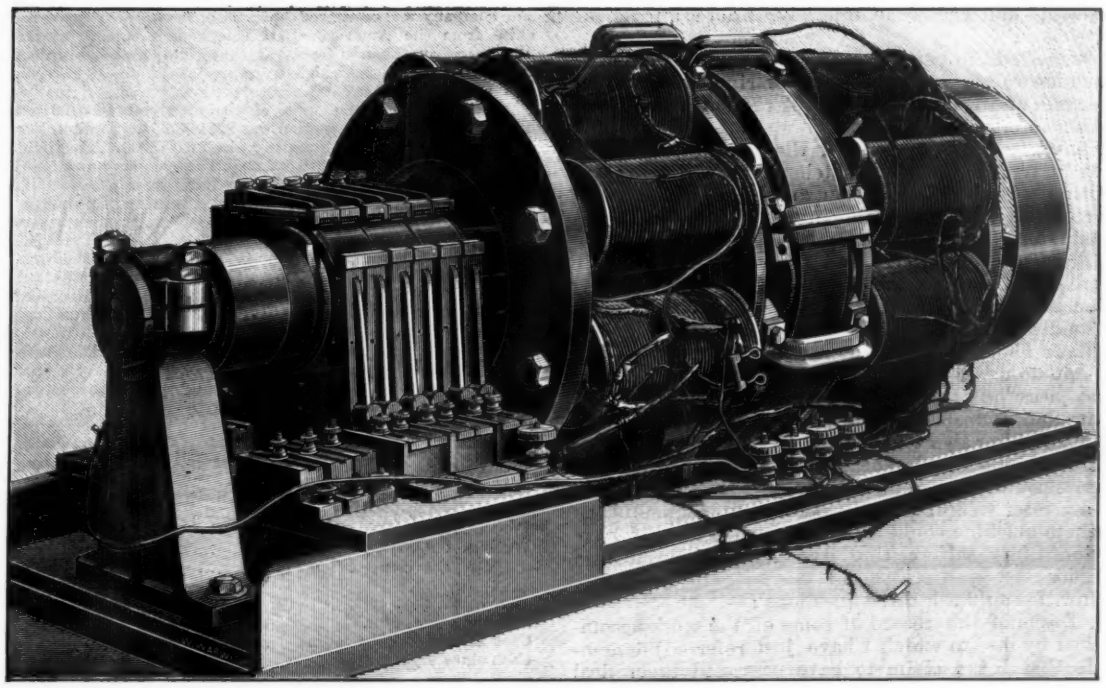
the company; Mr. T. E. Gatehouse also assisted at all these experiments, having at that time charge of the testing room.

The experiments included arc lighting, with lamps in series and parallel; attempts at the division of the electric light, including the Werdermann and other systems; the transmission of power; electro-plating; electro-decomposition, &c.

The machines employed included all the successive types as devised by Gramme, as well as modifications which were originated in the factory of the British Telegraph Manufactory, up to February, 1876.

On one occasion when experiments were being made with one of the largest sized Gramme machines at that time made, I had my hand resting on the framework of the machine, and as a consequence of a sudden change of resistance in the circuit I received a shock, and although I could only have formed a shunt with the machine itself and the circuit through me included the soles of my boots and the surface of a fairly dry concreted floor, the electric discharge was powerful enough to double me up, and I fell backwards on to the floor.

The discharge through me caused no conscious pain, but it had the effect of making me feel very



faint for some hours afterwards, and I was for some days unable to pursue my labours. A workman in the company's employ was also similarly affected by a shock from the same machine. Previous to my having received this electric shock, dynamo machines had been regarded as perfectly harmless, but when I came to reflect on my experience I clearly saw that if the conditions had been such that the whole of the discharge had passed through me, my name would probably have been handed down to posterity as the first victim as well as the first discoverer of the dynamo principle.

I have already alluded to the comparatively crude character of dynamo-electric accessories at the time when my 1876 machine was designed. Among other things, the governors which controlled the speed of the steam engine did not respond quickly enough, and consequently whenever the load of the engine was suddenly removed, which very frequently occurred in those days, from the breaking of the carbons in the lamps or various other causes, the engine raced, and we were obliged, during the whole time the dynamo was at work, to keep a man at the engine always on the look out to turn off the steam when the engine commenced to race.

In my machine this tendency to race was checked in a very great degree. My machine was worked after it was made, and developed a large amount of force, gving a very powerful light with one of the largest sized Serrin lamps used for lighthouse purposes. There are a number of witnesses ready to come forward and testify to having seen it at work. It was employed on one occasion at least to light up a large ice machine manufactured by Messrs. Siebe and Gorman to enable photographs to be taken.

In my specification I described one way, and one way *only*, of wrapping the field-magnets and connecting up the circuits, and this was a series circuit of low resistance wrapped on the field-magnets, in which the electric light or other external work was included, and a shunt circuit of higher resistance also wrapped on the field-magnets, which was always closed through the armature coils. This is an exact general description of a compound wound dynamo of the present time; and the fact that in my specification I described only one way of wrapping the field-magnets and connecting the two circuits wrapped on them should, I think, be considered as presumptive evidence that I had one object *only*, and that I designed one, and *only one* way of accomplishing it.

With the object of trying to explain away my plain and simple description, it is contended in the affidavits made on behalf of the plaintiffs that I did not have automatic self-regulation in view; in other words, that I did not know the electrical consequences of the plan devised by me.

To those who know my history, it may seem unnecessary to pay any attention to such a charge; but as I hope this communication may be read by some who do not know me, and as I wish to leave nothing unsaid which I think may help to support my contention that Brush has no claims whatever to be considered as the first to devise a system of compound winding, I will very briefly refer to my electrical career.

I have been, I may say, an enthusiastic electrical worker all my life. Before I was sixteen I had constructed nearly 300 Grove's cells of different patterns, making everything, including the porous pots, myself. I had also carried out magnetic researches to ascertain for myself the nature of magnetic force. I saw a Saxton's machine at about this time, and was disappointed to see so small an amount of electricity developed relatively to the size of the apparatus compared with that developed by a Grove's battery. I studied the subject

and detected the cause, and this led me to design and to commence the construction of a magneto machine; but although I had the advantage of a workshop, it was not supplied with engineering tools, and with the small means at my command I was not able to complete it.

The machine to which I have just referred, if it were *now* constructed as originally designed by me (I venture with my present knowledge to say) would favourably compete with a De Meritens, and take less space. I afterwards graduated in the workshops of the late Electric Telegraph Company, and in 1853, when I was twenty-one, I had charge of the instruments and telegraph lines of the Liverpool district, at a time when there was much pioneering work to be done. In 1855 I was appointed to the charge of the first field telegraphs used in war, and I saw service in the Crimea. In 1858 and 1859 I wrote papers, which were read before the Institution of Civil Engineers and the Society of Arts, on "The electrical qualifications requisite in long submarine cables," and on the "Practical bearing of the theory of electricity in long submarine telegraphy." In these papers I opposed the views on which the construction of the first Atlantic cable (at that time in course of manufacture) was designed, the said views having received either the active support or sanction of Siemens, Thomson, and Faraday;* and I may say of nearly, if not all, practical electricians.

I suggested the use of artificial submarine circuits, which have since enabled long submarine circuits to be duplexed, and I described the construction of one I was making in my paper of 1859.

I invented and introduced the one improvement made in Wheatstone's needle telegraphs which has revolutionised their construction, and I designed and constructed the first self-exciting dynamo (now at South Kensington), in which the dynamo principle was for the first time introduced, and for designing which I was awarded the gold medal of the Inventions Exhibition of 1885.

The discovery of what has been aptly termed by Sir William Thomson the dynamo principle was not an accidental one on my part. I had been working for some years on the subject with the faith that a self-accumulating machine would some day be produced, and had I been aware of what it seems was well-known to Profs. Holmes and Wheatstone, viz., that an electro-magnet could be magnetised by a magneto machine to lift a greater weight than the permanent magnets of the magneto machine could themselves lift, I should have produced my self-exciting dynamo in 1862 instead of 1866.

Now, I would ask three questions:—

1. Does not the record of some of the work accomplished by me (to which I have just referred) demonstrate that I can claim to have possessed theoretical and practical knowledge of the sciences of electricity and magnetism at the time I designed my dynamo of 1876.

2. Having been the first to discover the dynamo principle and to make a self-exciting dynamo, was it not probable that in the course of 10 years I should make a further advance.

3. Has any one the right to say when I describe one and *only* one special way of wrapping and connecting up the circuits of a new dynamo, designed by myself, that I did not understand the electrical consequences of my own arrangement.

Fortunately, it is in my power to set at rest absolutely the question as to how the circuits were to be arranged with respect to the machine and the external work.

(*To be continued.*)

* When I found there were grounds for the charge publicly made by Cyrus Field that I had gone in the face of Faraday, I submitted a copy of my paper to Faraday, who in the kindest manner immediately endorsed my views. As a matter of fact, Faraday had been misled by the scientific advisers of the Atlantic Telegraph Company, and I had been truer to his laboratory researches than he was temporarily at the time the problem of long submarine telegraphy was under consideration.

AMERICAN NOTES.

By "DAS TELEPHON."

UNDER the above caption I purpose to send to the REVIEW from time to time notices of passing events in the electrical world, which may be of interest to your numerous readers on both sides of the great Atlantic.

To-day I send you FACTS relating to the American Bell Telephone Company, which cannot fail to be interesting to the telephone companies and their subscribers in the United Kingdom. These *facts* were brought out from the witnesses under oath before the "Assembly Telephone Investigating Committee," which was appointed by the Legislature of New York State last spring. The object of the investigation is to obtain reliable information about the working of the telephone in the State of New York; the capital invested, the working expenses; number of subscribers, and royalties and other payments to the American Bell Telephone Company, which company owns the Bell patents, and many other valuable patents, and confines its operations to the granting of licenses and hiring out of telephone instruments. I have thus given you the position of telephone matters as regards the Bell Telephone Company, and will now give the testimony of a secretary of the Hudson River Telephone Company, which was taken by a stenographer:—

The Secretary stated that the territory of the company includes Warren, Saratoga, Washington, Fulton, Montgomery, Schenectady, Schoharie, Albany, Rensselaer, Greene, Columbia, Ulster, Dutchess, Sullivan, Orange and Putnam counties, in New York; Wayne and Pike, in Pennsylvania, and Sussex, in New Jersey. The company was organised April 27th, 1883, by virtue of a franchise from the American Bell Telephone Company of Boston. The territory taken up was at that time occupied by several smaller corporations, which were swallowed up. The company had at its start 1,097 telephone stations, which originally cost $600 per station, and 600 miles of wire at a cost of $100 a mile. The total cost of construction was $271,730.54. The total cost of the capital stock of the company was $2,000,000. The dividends from 1883 to 1887 were $219,822.59. The company now has 1,284 miles of pole wires and 800 miles of extra wires.

The actual cost of the Albany Company's property was $75,084.76. Another company was the New York and Vermont Company, the plant of which cost $11,745. The Troy and Hoosick Falls systems were also bought up. The entire cost of the systems taken, outside of the three main ones, was $271,730.54. The three main ones were the Albany, Schenectady and Hoosick Falls systems. The capital of the Hudson River Telephone Company at organisation was $50,000, which was increased to $2,000,000. It was divided into 20,000 shares, par value $100. The American Bell Telephone Company received $700,000 in stock for its franchise. The cost of the lines composing the Hudson River Company, Mr. Storke stated, was as follows:—

The Commercial, of Albany, cost		$75,084.76
The Construction Tel. Co. (Schenectady Exchange)		11,200.32
New York and Vermont		11,745.46
Amsterdam and others (1,097 extra stations) ...		109,700.00
Six hundred miles of line at $100		60,000.00
Four hundred miles of extra wire		4,000.00
Westchester, cost	$75,000.00	
„ construction	73,056.90	
		148,056.90
Making a total of		$419,787.44
Cash at organisation	$147,030.00	
Cash since organisation	$86,850.00	
		233,880.00
Total cash investment		$653,667.44

The Hudson River Company issued $839,120 in stock to the companies brought in and paid $233,830 in cash, making $1,073,000. The company has on hand $140,150 of its stock. When questioned as to the earnings, expenses, and dividends from April 27th, 1883, to July 1st, 1887, Mr. Storke produced the following statement:—

	Earnings.	Expenses.	Dividends.
To Dec. 31, 1883 ...	$38,063.34	$15,114.74	...
„ „ 1884 ...	146,179.98	86,352.97	$66,910,00
„ „ 1885 ...	172,804.93	115,106.85	49,270.49
„ „ 1886 ...	187,563.85	124,464.60	68,846.98
To July 1, 1887 ...	94,235.06	62,960.08	34,795.12
Totals	$638,847.16	$403,999.24	$219,822.59

The net earnings each year were $56,372.40. The capital stock on July 1st, 1887, was $1,859,850. At this time there were 2,841 stations, 1,284 miles of wire and poll lines, and 800 miles of extra wire, not including the New York and Vermont companies' lines. The company has paid out for construction $210,335.26. By the contract with the Bell Company only its instruments can be used by the company, and the Bell people will not receive any dividends from the Hudson Company till July 1st, 1888. When the patents on the Bell transmitter and receiver expire the Hudson Company will no longer pay $14 per annum rental on each appliance, although the contract calls for this payment perpetually.

The Westchester Telephone Company also was under investigation, and the following *facts* were elicited:—Although the West-

chester Telephone Company transacts business in its own name, it is really owned by the Hudson River Company, which, in its turn, is controlled by the Metropolitan Telephone and Telegraph Company, a stepchild of the American Bell Telephone Company of Massachusetts. To the last they all pay tribute.

When the Westchester Telephone Company was organised in July, 1882, it owned four general exchanges, 400 stations, and 50 miles of extra territorial wire. The company was capitalised at $300,000. There was, at the time, $15,000 in the treasury, and this amount was not included in the capitalisation. Stock to the amount of $100,000 was given in exchange for a franchise to the Metropolitan Telephone and Telegraph Company, and this franchise permitted the Westchester to do business in Westchester and Rockland Counties.

After securing permission to do business for a paltry $100,000 from the Metropolitan Telephone and Telegraph Company, the latter insisted that the Westchester Telephone Company must contract to do something further before it could begin the race for wealth. Mr. Storke was asked by Chairman Ainsworth to state the conditions in the contract.

"We pay the Metropolitan $14 annual rental on each receiver and transmitter," said Mr. Storke.

"Anything else?"

"We pay the Metropolitan one-third of our net earnings."

"Anything more?"

"The Metropolitan gets one-half the revenue of our telegraph business."

"And?"

"It also gets 60 per cent. of all toll-line business done between New York and Westchester."

"Is there nothing more?"

Mr. Storke blushed. "That is all," he said.

"How long does that contract run?" inquired Chairman Ainsworth.

"It is perpetual," replied Mr. Storke. He also said that in addition to the conditions stated the American Bell Telephone Company reserved the right of way for through business. It also paid $260 a month to the Hudson River Telephone Company for rent of its office.

But in spite of the chains in which it is bound the Westchester Telephone Company has been able to make money, a circumstance that demonstrated clearly how the public is gouged to satisfy the boundless appetite of the arch monopoly, the American Bell Telephone Company.

Something complimentary to his ruffled associates was said by Chairman Ainsworth, who returned to the charge by asking Vice-President Storke if he did not consider the royalties paid to the American Bell Telephone Company a heavy burden.

"The burden is too heavy," replied Mr. Storke, "and we cannot afford it." He understood that Bell's main patent on the telephone expired in March, 1893. The American Bell Telephone Company owned several hundred patents. If these patents were sustained by the courts the Bell Company might be able to hold its own beyond 1893. Were the royalties called off, telephone companies would be able to do business for a great deal less money of course. If the business were thrown open to competition, its development would be more wonderful, Mr. Storke thought, than now seemed possible. Mr. Storke considered the toll system the most equitable. Under the system adopted by his company a third of the business done was of the dead-head variety. He could not tell how much money the Westchester Telephone Company had paid in royalties to the American Bell Telephone Company.

An expert in the employ of the American Bell Telephone Company was called on to testify as to the expiration of the patents held by his company. He said that the oldest will not expire until 1893, and the youngest not until 1898 or 1899.

The cross-examination of Mr. Hovey, in which a telephone appliance was used, demonstrated that the Bell Company owns a patent on every part of the instrument, and that the patents expire in such a way as to protect this monopoly for a very long period of time.

The witness said that the American Bell Company has about three hundred and fifty thousand instruments in use, which means about one hundred and seventy-five thousand subscribers, and does not include the export instruments. Witness thought it very likely that the American Bell Company owned a controlling interest of the stock of the Western Electric Company, which owns the patents and manufactures all parts of the telephone not owned by the American Bell. The capital stock of the American Bell Company is $10,000,000, and it owns about $15,000,000 of local companies.

The shares of the American Bell Telephone Company were quoted on the Boston Stock Exchange on 14th inst. at $230 par value being $100.

The decision of the U.S. Supreme Court in the great Bell case, which was argued on appeal before that Court in February last, may be expected on any Monday; and in my opinion, which I have heretofore stated in the REVIEW, that decision will sustain Bell's patent, and the shares will advance rapidly. It is to be hoped that better instruments will be supplied to subscribers. My own experience with them is that they are the worst I ever used; very much inferior to those used by the U. T. Co. in London.

The investigating committee is to make a report to the Legislature when it meets in January next, when a Bill will be proposed to limit the price to be charged either for the hire or sale of telephones.

THE DEVELOPMENT OF THE MERCURIAL AIR PUMP.*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A.

(*Continued from page* 559.)

A more complex form of pump, in which the mercury was moved by air pressure, applied by pouring mercury into a second vessel containing air—somewhat on the plan of Hero's fountain—was described in 1824 by Dr. E. Romershausen,§ and in 1825 by Uthe.‖ In each case a complicated six-way tap was requisite.

In the same year a pump by Oechsle¶ was described, having a three-way tap connecting the pump-head alternately with the air and with the receiver to be exhausted, and provided also with a barometer gauge beneath the receiver. The mercury was lowered and raised, as in Edelcrantz's pump, by a large wooden piston, but worked by a chain and winch.

Next in strict historical order is the very remarkable pump of Mile, 1828, which, however, belongs to the third class of machines.

K. T. Kemp,** of Edinburgh, in 1830, designed a remarkable double-acting pump. In this machine a winch, manipulated like that of the ordinary mechanical air-pump, moves two pistons up and down in two cylinders (fig. 8). These are full of mercury, which is thereby driven alternately into the two exhausting

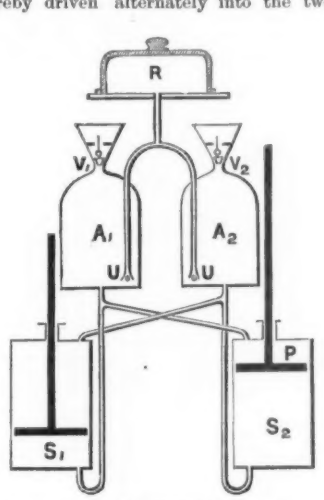


FIG. 8.—KEMP'S DOUBLE-ACTING PUMP.

chambers, and which serve as pump-heads. They are provided with valves to admit air from the receiver, and also with valves opening outwardly to let out the expelled air. The latter pair of valves are ingeniously provided with floats, so that they close while there is still some mercury remaining above the actual valve to seal the joint and make it air-tight. The double-pump of Gardiner described below (fig. 17), closely resembles that of Kemp.

The year 1855 brings us to the famous pump of the late Dr. H. Geissler, of Bonn, which in his hands did such excellent work for exhausting the Geissler vacuum-tubes. The first public mention of this pump appears to be in a pamphlet entitled, "Ueber das geschichtete elektrische Licht," published in Berlin in 1858 by Dr. W. H. Theo. Meyer. As depicted in that pamphlet, the apparatus strikingly resembles the second form of Baader's pump. The form given by Geissler to this apparatus is shown in fig. 9; which shows the vessel containing the supply of mercury, S, connected to the lower end of the barometric column, B, by a flexible India-rubber tube, *g*. The pump-head, A, is provided at the top with a large three-way tap, T. The operation of this simple contrivance is obvious; the air in the pump-head is repelled by raising the supply vessel, whilst the tap is in such a position that the pump-head communicates with the outer air. The tap is then turned so that the communication with the outer air is cut off, and communication is established with the vessel to be exhausted. This being done, the supply vessel is lowered down, when the mercury in the pump-head sinks, and draws in air through the exhaust tube. The tap is then turned again, and the supply vessel is again raised to expel the air that

* Read before the Society of Arts, Wednesday, November 23rd.

§ Romershausen. "Neue hydrostatische Luft-pumpe." "Kastner's Archiv für Naturlehre," ii., p. 359, 1824.

‖ Uthe. "Dingler's Polytechnisches Journal," xvii., p. 272, July 1825.

¶ Oechsle; see Wucherer: Beschreibung einer grossen Quecksilbernen Luft-pumpe, welche sich in dem physikalischem Cabinet in Karlsruhe befindet. "Kastner's Archiv," v., p. 329, 1825.

** Kemp. Description of a new Toricellian Air-Pump. "Edinburgh Journal of Natural and Geographical Science," ii., p. 95, 1830. See also in Fechner's "Repertorium des Experimentalphysik," i., p. 116; and Taf. 2, fig. 13, 14, 1832. Also "Baumg' und Ett. Zeitschr.," viii., 193.

has been drawn in, then the tap is turned and the supply vessel again lowered. By repeating these operations a sufficient number of times, the air remaining in the apparatus is reduced to a very small portion of its original amount, and the column of mercury in the tube, B, stands up to very nearly the height of the barometer. The perfection of the vacuum is limited by two causes: the inherent imperfection in the three-way tap, and the impossibility of expelling the film of air which adheres to the inner surface of the pump-head. However perfectly the tap may be ground into its seat, however carefully it is lubricated with stiff grease, still, air-films will remain between the working surfaces. There is a tendency for a channel to be formed in the film of grease at that part of the conical periphery of the tap where the apertures into it slide round against the internal wall of the glass seat; and through this channel in the glass, minute bubbles of air force their way. Moreover, the grease itself may give off vapours which spoil the perfection of the vacuum. The Geissler pump is, moreover, subject to other defects, amongst which may be enumerated the heavy labour of raising and lowering the supply vessel, the liability to accident to the glass top, the liability to fracture of the pump-head. The latter accident occurs not unfrequently, if, after a certain degree of exhaustion has been attained, the supply vessel is suddenly raised, for then, there being little or no air in the pump-head to serve as a cushion, the mercury rising in the pump-head strikes with a sudden blow against the upper portion of the pump-head and fractures it. The long barometric tube or shaft of the pump is also liable to fracture. The working of the tap, being done by hand, requires continuous attention; lastly, the process of exhaustion is slow.

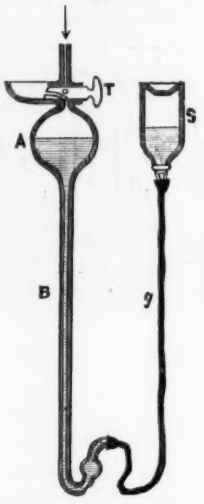


FIG. 9.—GEISSLER'S PUMP (FIRST FORM).

The subsequent improvements relate to the removal of one or other of these drawbacks. Some of them were introduced by Dr. Geissler himself, and by his successor, Herr F. Müller, of Bonn. The form depicted in Fig. 9 (taken from Toepler's paper in "Dingler's Polytechnisches Journal," clxiii., p. 426, 1862) shows the kind of three-way tap (a modification of Sengueerd's) originally used, in which the passage for the expulsion of the air was carried through the conical body of the tap to its end. In another form, the same kind of tap was used, but the exhaustion was made through this longitudinal passage, the external tubular seat being prolonged and connected with the vessel to be exhausted. In this case the air was expelled upwards through the transverse passage through the tap. In yet a third form the exhaust tube was sealed on at right angles to the external barrel, and the tap was pierced (on Babinet's plan) with a three-way transverse passage. In the most recent form given to the Geissler pump by its makers, there are three taps, one of them, a large one, being a three-way tap of the last-mentioned kind, simplified by having only one transverse bore of conical form. The arrangements of this pump are shown in fig. 10, in which T_1 is the three-way tap, and T_2 and T_3 plain taps of a smaller size. The use of the two upper taps is to enable the last traces of air to be more perfectly expelled from the pump-head. During the ordinary working of the pump the two top taps are always left open. After the exhaustion has reached a sufficient point, the large tap is turned so as to cut off communication with the exhaust tube, and to open communication from the pump-head upwards through all the taps. The supply vessel is then raised so high as to drive the mercury up above the level of the topmost tap. The top tap is then closed, and, by sinking the supply vessel, the mercury is caused to fall below the pump-head. It is then slowly raised, driving before it all the air that may remain in the pump-head, and collecting it just below the top tap. As soon as the mercury has risen through the second tap, this is then closed, and the mercury once more lowered. It will be seen that if the space between T_2 and T_3 is sufficiently great, this residual air will not become compressed to anything like atmospheric pressure, and hence the air-films forming in the upper part of the pump-head or in the channels of the three-way tap will be comparatively slight. The curved tube at the top is used for collecting the gases extracted in chemical operations; the horizontal exhaust tube is usually connected with drying-vessels, and with appropriate gauges. The complete pump as used for the purposes of the chemical laboratory as shown in fig. 11.

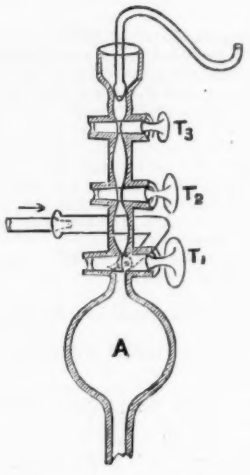


FIG. 10.—GEISSLER'S PUMP (RECENT FORM).

Morren's pump* is practically identical with Geissler's, save in a detail concerning the three-way tap, which has, instead of having a glass cone with a longitudinal passage pierced through it, a steel cone, with a channel or groove cut in the side. Another almost identical form was described by G. Jolly,† about the same time. It resembled Geissler's first form, but was provided with a mechanical device of a winch and pulley, to raise and lower the supply vessel. This device was speedily adopted by other makers;

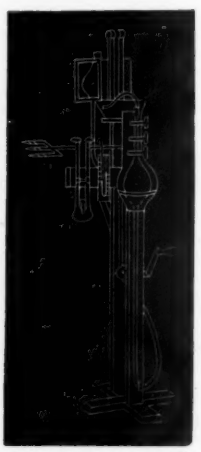


FIG. 11.—GEISSLER'S PUMP (COMPLETE).

it may be seen in the latest form of Geissler's pumps. Jolly's pump also has a steel three-way tap. Von Babo‡ sought to replace the egg-shaped pump-head by a glass cylinder, strongly held together between circular steel ends, and having two automatic valves opening into and out of it, precisely as in Kemp's pump of 1830 (fig. 8). Poggendorff§ further improved the mechanical lift by adding a counterpoise weight. Alvergniat‖ introduced an automatic valve into the exhaust tube, to prevent the mercury from being driven back into the exhausted vessel. Weinhold* modified the glass three-way tap, and added above it a small chamber, above which the opening into the outer air was closed by a second glass tap of simple construction. The use of this upper chamber to secure a more perfect vacuum brings this form almost into identity with Geissler's later form. The device of inter-

* Morren. "Annales de Chim. et de Phys." March, 1865. See also "Carl's Repertorium der Physik," vol. i., p. 142, 1866. It is depicted in Ganot's "Physics" (1879), p. 158.

† Jolly. Ueber eine neue Einrichtung der Quecksilber-Luft-Pumpe. "Carl Repert," i., p, 144. 1866. See also Müller-Pouillet's "Physik" (ed. 1876), vol. i., p. 231; and Mousson's "Physik" (ed. 1879), i., 1878.

‡ Von Babo. See Müller-Pouillet," i., 233.

§ Poggendorff. "Pogg. Ann," cxxv., 151.

‖ Alvergniat. See Pellat, "Cours de Physique," (1883), i., 319.

posing such a chamber between the three-way tap and the external air was independently suggested in 1875 by Kundt and Warburg,† and appears to have been already adopted by Geissler‡ in 1873.

In the years 1873 and 1874, Dr. Joule§ devised several forms of mercurial pump, having but one valve, an India-rubber plug, V, fitting into a cone seat at the top of the pump-head, allowing the air to be expelled. A little mercury above it kept the joint

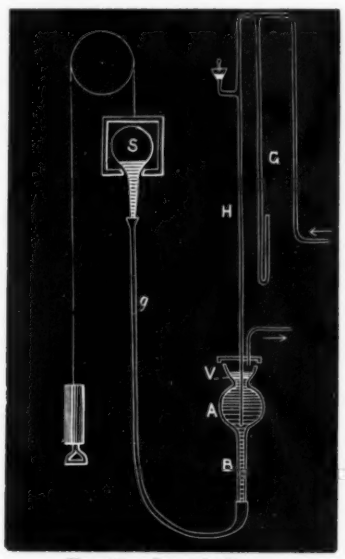


FIG. 12.—JOULE'S PUMP.

secure. The necessity of emptying a second valve was obviated by the device (previously used by Mile) of connecting the vessel to be exhausted to the pump by means of an overhead tube, H, of more than barometric height which passed into the pump-head its open lower end descending nearly to the bottom of the chamber. This acted automatically as a trap; for, on the raising of the supply-vessel, the mercury rising in the pump-head first closed the orifice of the head-tube, so cutting off communication with the air that remained in the pump-head, but never rising in that tube

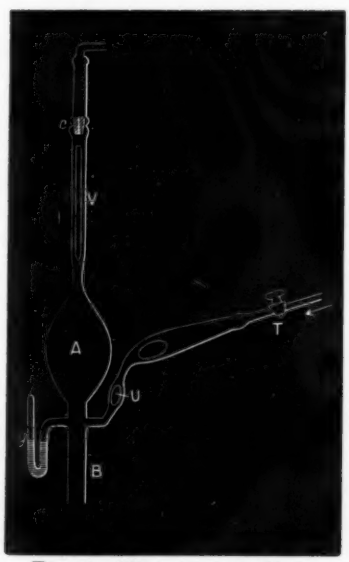


FIG. 13.—MITSCHERLICH'S PUMP.

to a height greater than 76 centimetres above the level of the valve. Another feature of Joule's pump was that the supply-vessel was closed at the top, being made of a globular flask. By allowing only a certain amount of air to enter this flask, the pressure inside was kept at less than atmospheric, enabling the length of the shaft, B, to be reduced. Later, a conical ground-glass tube was used in place of the India-rubber plug for a valve.

In 1873, Mitscherlich* altered the pump in the manner shown in fig. 13. The double function performed by the three-way tap was in this form shared between an automatic valve, V, opening upwards only, and a plain glass tap, T, worked by hand. The valve consisted of a rod of glass, ground conical at its lower end, fitting into a tube of one centimetre internal diameter. This rod was raised from its seat by the mercury as it rose through the pump-head. A perforated cork placed in the eject tube above the valve prevented it from rising too high, otherwise it would, in falling, become jammed. The exhaust tube communicated with the pump through the tap, T, at a point below the pump-head; the communicating tube being enlarged to receive an hydrous phosphoric acid or other drying materials, the same being protected from the rising of the mercury by the interposition of a loosely-fitting glass valve of ovate shape, U.

Another modification, due to Lane-Fox,* is shown in fig. 14. The valve at the top of the pump-head is a conical glass stopper

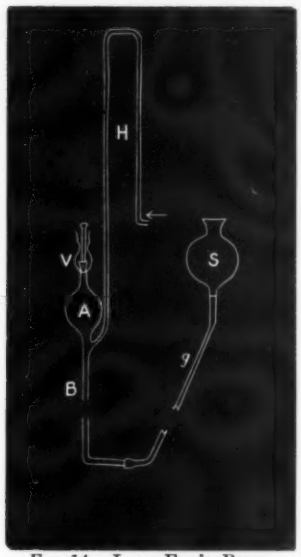


FIG. 14.—LANE-FOX'S PUMP.

ground to fit tightly into its seat, requiring to be removed and replaced by hand. The overhead tube, H, which acts as a barometric trap, is joined to the shaft of the pump just below the pump-head. Lane-Fox also suggested the use of an automatic valve (like that of Alvergniat) to obviate the necessity of using the tall head-tube. This pump was for a long time used by the Anglo-American Brush Electric Light Corporation for exhausting the Lane-Fox incandescence lamps; they introduced a number of modifications in detail, one of which consisted in replacing the stopper, V, by an automatic valve resembling Mitscherlich's. A side-tube leads from below the lower automatic valve, U, to the tap of the pump-head. There is also a spark gauge. A drawing of one of the intermediate forms of Lane-Fox pump is given in Gordon's "Electric Lighting" (1884), p. 83.

About the same date, minor improvements were suggested by several persons. Mr. Dew-Smith, of Cambridge, suggested the use, at the top of the pump-head, of an automatic valve consisting of a strip of rubber or silk stretched over an orifice, precisely as in many mechanical air pumps, the valve itself being surrounded by an upper mercury cup to ensure a tight joint. Messrs. Goebel and Kulenkamp,* who used an automatic glass valve to close the top of the pump-head, adopted above it a flexible tube, by means of which to return to the supply-vessel the small quantities of mercury which from time to time were driven up through the pump-head, with the ejected air. Guglielmo,† applying a very similar device, achieved the not unimportant result of causing the tap at the top of the pump-head to discharge the ejected residual air into a space already partially exhausted. This he accomplished by interposing in the flexible tube connecting the summit of the pump-head with the closed top of the supply-vessel a vertical glass tube, about 20 centimetres long, with a three-way tap opening also into the air. Through this tap atmospheric pressure could be momentarily established when the supply vessel was in its lower position, and nearly full of mercury. When it was raised, the mercury ran out of it into the pump-head, leaving the space in it partially exhausted; and into this vacuous space the three-way tap at the top of the pump-head opened to let out the ejected air. As will be seen later on, this device makes this pump resemble somewhat some pumps of the third group.

Mr. Albert Geissler‡ has replaced the three-way tap by two automatic valves (fig. 15, p. 30), one of which, V, opens from the top of the pump-head into the outer air; the other, U, admits air frem the vessel to be exhausted into the pump just below the pump-head, as in the Mitscherlich and Lane-Fox pumps. These valves are hollow tubes of glass, with spindle ends to guide their motion, which float in the mercury when it reaches them. They are provided with accurately ground glass collars instead of conical

* Weinhold's. "Physikalische Demonstrationen" (1883) p. 175. See also "Carl's Repert," ix., p. 78, 1874.
† Kundt and Warburg. "Pogg. Ann.," 526, 1875.
‡ See Bessel-Hagen. "Wied. Ann., xii., 436, 1881.
§ Joule. "Proc. Lit. Phil. Soc. Manchester," xii., 57, 1873; *ib.* xiii., 58, 1874; *ib.* xiv., 12, 1875; see also "Scientific Papers," i., 623; also "Catalogue of Loan Collection of Scientific Apparatus," 1876, p. 133.

* Mitscherlich. "Pogg. Ann.," cl., 420, 1873.
* Lane-Fox. Patent Specification 3,494, of 1880.

ends, to fit against the ends of the tubes which they respectively close. An additional tap, T, is interposed for safety between the pump and the vessel to be exhausted. Other tubes lead to the manometric gauge and to the drying apparatus. This form of pump is intended for industrial use, where power is available to keep the supply-vessel slowly rising and sinking. A small improvement of recent date, due to Messrs. Greiner and Friedrichs,* consists of a new three-way tap of peculiar construc-

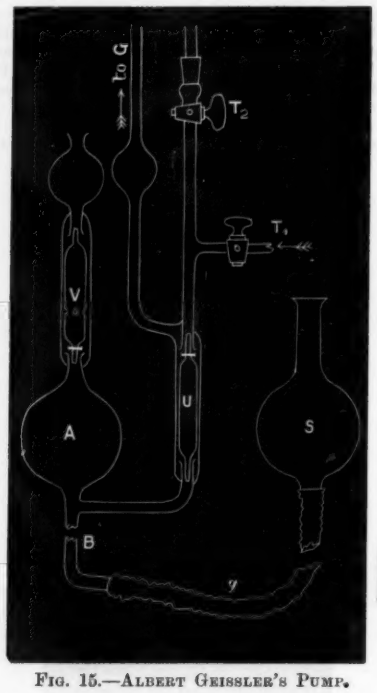


FIG. 15.—ALBERT GEISSLER'S PUMP.

tion, pierced with two transverse channels at 45°. Of the three openings, two are at one side of the barrel, one at the other, so that the top has to be worked through 180° instead of 90°, and the channels in the grease do not lead directly from one aperture to another. Hence there is a lesser risk of leakage.

(To be continued.)

STORAGE BATTERIES AND ELECTRICAL DISTRIBUTION.

By RANKIN KENNEDY.

DISTRIBUTION systems have now arrived at sufficient perfection for extensive testing, and the leading systems have been already tried widely enough to enable electrical engineers to draw conclusions as to the practical values of the various methods of distribution.

The direct supply at 100 volts on a three-wire system has been extensively applied. This system is the very acme of simplicity; but it cannot be extended over wide areas at reasonable costs, and therefore commercially it is a failure.

In this system storage batteries may be used freely, both at the consumer's end and at the central station; but if the system does not pay in its simplest form it is not likely to pay, or even to be at all considered, as a distribution system. If storage batteries are introduced, the added cost and maintenance of the batteries would be prohibitive to the use of such a system.

The next system which may be considered as having passed through its practical trials is the high-pressure alternating current and transformer system, recently described fully. In this system storage batteries cannot be used by the consumers, the consumer gets his supply from a transformer direct.

This want of storage at the consumers has been raised as an objection against the alternating system; but some of those who have had most experience in supplying by this system maintain that storage by the consumer is unnecessary and undesirable; first, on the ground of cost; and secondly, on the ground of attendance required by the battery, which if left to the consumer would be neglected, and if in the hands of the supply firm would entail cost of wages; in fact, this high-pressure alternating system may make the gas supply system its model. No consumer of gas thinks of storing gas on his premises; but it may be urged that a breakdown of the transformers may occur; such an occurrence is possible, but practically, all but impossible. Transformers are far less liable to break down than storage batteries; in fact, a consumer would be less likely to lose his lighting from a breakdown of a transformer than he is to lose his lighting from a breakdown of his gas meter.

Of course, transformers can be made, and have been made, that will break down; but no one who has made them will deny that they can be made so that a breakdown is as nearly impossible as the breakdown of anything made by human skill.

Although it would thus appear that storage by the consumers is of no account in any system, gas or electric, it is of equal and great importance to both at the generating station. Gas distribution would be impossible if storage at the central station could not be accomplished, and every electrician agrees upon the necessity of storage at the electrical central station. Out of ten failures nine occur at the central station; with its complex arrangements it is the weak spot in all systems. Boilers, pumps, valves, engines, belts, pulleys, bearings, dynamos, and other appliances are here continually wearing and requiring repair; and sometimes a failure of some very small and apparently trifling part of all this organisation causes a complete stoppage of the whole.

Upon these considerations it is imperative that storage should be taken into account at every central station; the whole question is one of cost.

Of course, the chances of the failure of the storage battery should be taken into account; they should be about as reliable as the gasworks gas-holder before adopting them largely for central station work; only on the ground of perfect reliability, and on that alone, can their use be advocated at all.

Taking it for granted that storage is commercially permissable and practically perfect, we can employ it at an alternating current station; thus we can easily store a large current at low pressure, and convert it into a small alternating current at high pressure, and distribute it to the mains in this form.

A combined motor and alternating generator is used for this purpose; the motor armature is driven by the low pressure large current, and being on the same shaft as the generator armature, generates an alternating current of any given pressure to pass into the mains. Such an arrangement provides against any failure occurring in the mechanical arrangements at the central station, and that is about all that is required.

Lately the high-pressure continuous current system has been advocated again; nothing has been done with it on a practical scale of distribution, although the transformers have received some attention.

In this system the consumers may have storage from the transformers, if that is of any advantage. Against this must be placed the attendance required by both transformers and storage batteries, both being subject to wear and tear.

At the central station, if storage batteries are to be used direct to the mains, then a vast series of them are required for, say 2,000 volts pressure, about 1,100 batteries would be required in series. Fewer storage batteries could be used by employing a combined motor and generator to raise the pressure from 200 to 2,000 volts. In that case, 110 storage batteries could be used.

* "Wied. Beiblätter," vi., 849. 1882. See also Specification of Patent 5,548 of 1881.

† Guglielmo. "Wied. Beibl," viii., 739, 1884.

‡ A. Geissler. "Centralzeitung für Optik and Mechanik," vii., 12. 1886; also D. R. Patent, No. 32,224, 1885.

* Greiner and Friedrichs. See "La Lumière Electrique," xxiii., 335, 1887.

Such an arrangement has no advantage over the same for the alternating central station, but would have some difficulties in collecting the 2,000 volt current at the generator, which are not present in the alternating generator; and then there are also difficulties in the commutating of motors on the consumers premises working at 2,000 volts.

It would appear that if any one of the storage battery makers would bring out a cheap enough battery for central station work, they would no doubt receive a fair trial on a large scale with both alternating and continuous current transformers. As the matter stands just now the adoption of storage raises the cost to such a degree that no central station except a few in very favourable situations could obtain customers at paying rates.

In some wealthy quarters in London a rate of 8d. per unit may be easily got; at such a rate a central station employing storage might be run without any loss. But a really popular rate to compel the ready adoption of electric lighting anywhere and everywhere must compare with gas rates. In fact, in few towns of any size would a rate for electricity of more than 4d. per unit be acceptable. The only system known to the author really able to work at or very near this low rate and realise a profit is the alternating system without storage.

There is another item of cost in electric lighting which proves a heavy obstacle to progress in central station electric lighting, and that is the monopoly in lamps; we can get along somehow without storage batteries until they get cheaper, but good or bad, cheap or dear, we must have lamps; the restrictions on the manufacture of lamps in Great Britain make electric lighting progress exceedingly difficult.

In fact, the two great questions for the consideration of electric engineers with a view to future progress are: first, how to obtain cheap storage; and second, how to obtain lamps at 1s. each with a life of 1,000 hours.

These two problems solved, electrical engineers in this country would find more work to be done than they could undertake without largely increasing their business.

Cheap storage may be obtained, but the lamp appears a hopeless case until it is free to all manufacturers to make and sell in competition in the market.

OBITUARY.

JOHN ST. LAWRANCE BEAUFORT.

WE regret to announce the death of Mr. John St. Lawrance Beaufort, B.A., postmaster of Manchester, which took place at his residence, The Roost, Prestwich, last week. Mr. Beaufort was the fourth son of the late Rev. W. L. Beaufort, Rector of Glanmire, near Cork, and his mother was the eldest daughter of the Hon. and Right Rev. Thomas St. Lawrance, Protestant Bishop of Cork and Ross. He graduated as B.A., in the Dublin University, and was preparing to study for the bar, when he was offered an appointment in the Post-office which he accepted, and in 1839 he entered the service on the surveyor's staff in the northern district of England, under Mr. John Tilley, late Secretary to the Post-office, and afterwards Sir John Tilley, K.C.B. This was the year in which Rowland Hill's grand scheme of postal improvement was initiated. After serving for about 15 years in the north he was appointed surveyor to the North Wales district, which included Liverpool; and shortly afterwards was removed to the Midland district, which extended from London to Birmingham, Worcester, &c. After a residence of about four years in London Mr. Beaufort accepted the postmastership of Manchester, which became vacant by the retirement of Mr. Willack in 1860.

The deceased gentleman was one of the earliest to perceive that female labour could be utilised in the telegraph department of the post-office. He obtained authority to open a school for the training of candidates, and the learners, as soon as they became acquainted with the work, were employed in the department. The nucleus was thus formed of a female staff which has now reached nearly 200.

Mr. Beaufort's death has been heard of with considerable regret in all the London branches of the postal and telegraph departments. He was exceedingly well known in the post-office at St. Martin's-le-Grand, and took a most active part in the framing of the scheme for the sixpenny telegrams, and in the making of arrangements for many of the postal and telegraphic facilities which have been extended to the public in recent years. He was closely identified with all the postal reforms which Mr. Fawcett introduced, and his opinion was invariably consulted when any contemplated arrangements were made in the postal and telegraph system. He was one of the first postmasters who thoroughly grasped the importance of extending special facilities to the Press in the case of political gatherings taking place in his district, and frequently set aside obstacles which tended to interfere with the prompt transmission of speeches or other matters of importance.

We regret to announce the death, which occurred on the 1st inst., of Franz Carl Guilleaume, of the well-known firm of Felten and Guilleaume, at the comparatively early age of 53 years.

THE GOVERNMENT AND THE CABLES.

THE Central News is enabled to state that the negotiations between the French and English Governments for the joint working of the submarine cables across the English Channel have progressed so far that no doubt whatever is now entertained but that a satisfactory working arrangement will be arrived at. After the return of M. Coulon, the French Postmaster-General, to Paris, the negotiations were continued by M. Waddington, the French Ambassador, and the provisional agreement arrived at has been taken by his Excellency to Paris for ratification by his Government.

In the meantime the directors of the Submarine Telegraph Company who were dispatched to Paris with a view to influencing the French Government in their behalf have returned to London and reported the failure of their mission. The French Government are so far committed to the proposals of the English Government, that they distinctly decline to consider the question of any prolongation of the concession to the Submarine Telegraph Company. The English Government have been equally firm, the final resolution of the Cabinet just communicated to the Submarine Company setting forth that having thoroughly examined the question, they have "decided not to grant a prolongation of the company's license to land cables on British shores, and not to renew after January 12th, 1889, the working agreement between the Postmaster-General and the Submarine Company."

This communication really concludes the matter so far as the company is concerned, as if they cannot "land cables on British shores," it puts an end to their business. The only hope for the company lay in their being able to persuade the French Government to thwart the scheme of the British Post Office.

The Post Office is desirous of dealing generously with the working staff of the Submarine Telegraph Company, "recognising that it is a large and deserving one." Many of them have been the first workers of the Submarine Telegraph Company They are experienced, and could only by degrees be replaced. This resolve of the Government is certain to meet with full and general approval.

But though the authorities will fully consider the claims of the staff, they are still disinclined to pay anything more than the bare value for the cables and plant; and, as the cables are practically valueless to anyone but the Post Office, it follows as a matter of course that they will get the cables they require upon their own terms.

The contention of the Government is that the concession to the Submarine Company was for a limited term, and that the directors recognised the precarious nature of their holding by building up a reserve fund to meet the possible contingency of a further concession being refused. As the Submarine Company will be able to pay their stock at par, the authorities fail to see that anything further is required.

So far as the cables are concerned, the four which connect with France are in good order, recent repairs having made them almost as good as new. The two single cables to France now used by the American Telegraph companies are also working very well. The two Belgian cables are in a fair condition, and possibly, taking all these facts into consideration, the British Treasury may make a more generous offer to the company than would otherwise have been the case.

The telegraphic rate between England and France will, when the final transfer is effected, be reduced to 2d. per word, but the special rate for Press telegrams has not yet been fixed.

In reference to a statement which has been published to the effect that nine years ago Lord John Manners entered into an agreement with the Submarine Company which practically encouraged the belief that the concession would be renewed, the Central News understands that this agreement ceased to be binding long since, the Government notifying the directors that they "had failed to fulfil the clauses imposed upon them, and had even worked against the spirit of the agreement. The Government, therefore, did not feel bound in any way by the said agreement."

REVIEWS.

The World's Workers. Thomas A. Edison and Samuel F. B. Morse. By VAN BAREN DENSLOW, LL.D., and JANE MARSH PARKER. Cassell & Company, Limited, London, Paris, New York and Melbourne.

This small book is brightly and entertainingly written, and although perhaps no new historical facts are introduced, yet the freshness of the style will render the reading of the book a pleasure even to those who are acquainted with the statements given. To many, however, the information will be new and will afford great entertainment if they are at all interested in biographical sketches of workers in science.

Recent Advances in Electricity, Electric Lighting, Magnetism, &c. Edited by HENRY GREEN. New York agent, College of Electrical Engineering.

This pamphlet (for it is nothing more than a pamphlet of 55 pages) is priced at 4s., and we can unhesitatingly say it is the worst 4s. worth we have come across. The information afforded is meagre in the extreme, and the few illustrations given are ill chosen. Altogether, in fact, the production is not one of which the editor has cause to be proud.

NOTES.

Breakdown at the Vienna Opera.—We are informed that the facts relating to the failure of the boilers at the Vienna Opera are as follows:—Six steel boilers of 120—140 H.P. each were made for Messrs. Crompton and Company by the Witcourtz Iron Company in Moravia. Messrs. Crompton specified that the material used should be the best mild steel ordinarily used for boiler making. From the very first, however, the steel actually used began to give trouble; one of the plates in the water leg cracked under cold water pressure when it was tested, before steam was got up, and two other boilers failed within 48 hours of starting work. These defects admitted of temporary repairs; meanwhile, work was carried on with the other three boilers. After about 12 weeks' work, however, similar cracks began to show themselves in the main shell of the boilers, which were then considered dangerous, and the work was stopped by order of an Imperial Commission. The cracking is one of those instances which so often occur with steel boilers; we may instance that of the Czar's yacht, the *Livadia*, which excited great interest among marine engineers. The cracks in nearly all cases appeared when the boilers were cooled down and opened up for cleaning purposes. The steel used was Bessemer produced by the basic process. The whole of the six boilers were got out from the underground boiler house, and two large sized locomotive boilers that happened to be available were got into position, and steam got up within nine days of the order to stop the defective boilers. The Opera was lighted on the tenth day. The whole of the rest of the machinery was found to be in perfect order, the accumulators not having suffered in the least. With the exception of this one failure of the boilers there has been no hitch whatever in the running of this large installation of 6,000 lights since the commencement.

Theatre Lighting.—*The Revue Internationale de l'Electricité* contains an able lecture by M. A. Vernes on electric lighting considered from the point of view of safety in theatres. He points out that a glow lamp will burn as well under water as in the air, and that the increase of temperature which they produce in theatres, &c., scarcely amounts to one-twentieth of that which would be occasioned by gas burners. This absence of heat given off is a capital point as regards safety from fire. Where gas is used the wood-work, decorations, &c., are kept at a temperature of 80° to 90° F., and are consequently ready to burn rapidly. The speaker placed a morsel of gun-cotton on a glow lamp and showed that it did not take fire. If such a lamp is broken the carbon filament is at once dissipated and the light is extinguished. It is, however, necessary to be sure that the conductors are arranged with due care, since if the wires come in contact an abnormal heating is to be feared. If, however, we observe the rules indicated by Edison, all accidents are excluded. He introduces circuit-breakers of fusible metal in all the secondary derivations. If a wire becomes heated the fusible metal melts and the current is cut off.

The Electric Light at Bicester.—Some experiments are being made with the electric light in the town of Bicester, with a view to its introduction into several private residences.

Broadstairs and the Electric Light.—At the last meeting of the Broadstairs Local Board, a letter was read from Mr. W. Hamilton, who has carried out the lighting of Herne Bay by electricity, in reference to the lighting of the district, giving as his reason for so doing that it had come to his knowledge that the ratepayers of Broadstairs thought there was room for improvement in the street lighting, both as regarded efficiency and economy. After explaining the advantages of his system, he stated that he had carefully considered the town and was of opinion that it could be lit by 12 lamps of 1,000 candles each, and 20 incandescent lamps of 20 candles. The cost of supplying all the necessary apparatus would be £700, and the cost of street lighting including all expenses would be less than £350 per annum. Mr. Newling asked how it would be if Mr. Hamilton lit Broadstairs at his own risk for three months, to see how they liked it. The letter was referred to the Survey Committee.

Electric Lighting in Country Houses.—Benhall Lodge, Suffolk, the seat of Mr. Edmund Hollond, is now lighted throughout by the electric light, the installation having been carried out by Messrs. J. Edmundson and Company. The dynamo is driven by an engine of the ordinary agricultural type of 8 horse-power nominal, and is capable of easily working 100 16-candle-power lamps. In addition to the dynamo there is also an accumulator capable of working 75 lamps of 16 candle-power for 9 or 10 hours. The engine-house is about 150 yards away from the mansion, and the wires are laid underground, securely protected by leaden pipes. In the ordinary way the engine will be run for a few hours during the daytime, in order to charge the accumulator, at the same time doing other work, such as sawing wood, pumping water, &c. The pumping will be effected by means of an electric motor, as the pump is at some distance from the engine. Ordinarily the accumulator alone will supply the lights, but on special occasions, when all the lights are wanted, the engine will be at work during the evening also. There are altogether 157 lamps distributed throughout the house and stables. There are 39 in the three drawing-rooms, some placed near the ceiling—in the centre-piece—some on the lustres and others in the form of hand lamps. A similar installation has been lately made by the same firm for Sir Edward Guinness, at Benacre Hall.

Electric Lighting in Canada.—Guelph, in Canada, is to be lighted by means of 16 arc lamps, the cost of which is estimated at 43 cents per light per night.

The Lighting of Theatres.—A valuable contribution to the subject of lighting theatres has, says *Iron*, been given by Prof. Dobroslawin, of St. Petersburg, in a paper on the comparative use of gas and electricity for lighting theatres. Referring to the experiments made by Prof. Pettenkofer and Dr. Renk, Prof. Dobroslawin, with the assistance of Dr. Kowolkowsky and Dr. Bosaroff, made last February, during the three days' carnival at St. Petersburg, when the largest crowds filled the theatres, experiments on the temperature and ventilation of the Grand and Alexander Theatres, lighted with gas, and the Maria Theatre, lighted with electricity. These three theatres gave each two performances daily, and each held about 1,600 people. The thermometers were so placed as to be on a level with the audience. The carbonic acid was determined by the Pettenkofer method. As is well known, the temperature falls between the acts; and it was found that the temperature in the galleries did not fall as rapidly as in the pit. As a result, the professor thinks that people seated in the pit are more apt to take cold than those in the upper parts of the house. The highest degree of temperature with electric lighting was 25° C., and with gas 33° C. Prof. Dobroslawin does not think that the difference of air is noticeable with either kind of lighting. Finally, the professor concludes that electricity is far superior to gas from the standpoint of health.

Mr. Ralph Nevill, F.S.A., read a paper on "The Auditorium of a Theatre," before the Royal Society of British Architects on Monday evening, in the course of which he said lighting ought to be regarded by the manager as a potent means of inspiriting an audience. It might be accepted that the electric light would be used, but nevertheless provision must be made for gas. To be successful artistically the light must be various. In the event of fire the electric light would be extinguished; the gas sunlight ought therefore never to be put out, but turned low during the performance, and turned up full between the acts, the electric light being turned quite out in the first case, so that the eye was entirely drawn to the stage. The front of the circles was the natural place for electric lights. The electric light rendered no great provision of fresh air necessary during a performance. It would, however, be always requisite to provide an exit for impure air; and as long as gas was used behind the scenes, there must be sufficient ventilation to take away the enormous and dangerous heat at the top, without creating a draught to the stage.

Electric Lighting at Ipswich.—"A Shopkeeper" of Ipswich, writes to the local papers, as a result of the lighting of the public hall last week, asking why Ipswich should not have a central station. He, for one, would be glad to avail himself of the light, at a cost even greater than that of "the vile compound now supplied us and called gas."

Electric Lighting for Ramsgate.—We understand that several gentlemen having called upon Mr. R. Coveney, electrical engineer, with reference to lighting the shops, &c., of the principal streets in Ramsgate, he has made arrangements with a London firm to lay down an installation providing 1,000 incandescent lights can be guaranteed. The cost will be ¼d. per hour for 8 candle-power lamps, ½d. per hour for 16 candle-power lamps. Steps will be immediately taken to prepare the installation.

Electric Lighting in Swansea.—The *Cambrian Daily Leader*, in an article entitled "The Electric Light in Local Works," recently described a number of installations which have been put up by the agent of the Anglo-American Brush Electric Light Corporation (Mr. J. S. Brown) in and around Swansea. From this it appears that a good deal of very satisfactory electric lighting work is going on in South Wales.

Electric Lighting in Japan.—The electric light has been introduced in the Osaka Bazaar, which has in consequence received a great increase of visitors.

Ship Lighting.—There was launched from the Greenock yard of Messrs. Russell & Co., on Monday, a screw-steamer, 310 feet by 39 feet by 25 feet, for the petroleum bulk-carrying trade between New York, Hamburg, and Bremen. She is being fitted throughout with the electric light by Messrs. J. H. Carruthers and Company, of Glasgow. The Clyde dynamo, driven by a vertical inverted cylinder engine, and made by Messrs. Carruthers, is to be employed. There are 50 lights in all. The installation is being carried out under the superintendence of Mr. James Campbell.

Canterbury and the Telephone.—We recently mentioned that the subject of the telephone was under the consideration of the Canterbury Town Council. Nearly the whole of a meeting held on Wednesday last week was devoted to its discussion, and a strong opinion was expressed that "a little stationary town like Canterbury" did not need the telephone. The forceful reply of Mr. Alderman Hart was that if Canterbury was little, it was because there were little-minded people in it. The proposal before the meeting was that the Council should pay £40 a year for the use of eight stations in connection with the exchange which it is desired to erect; but, unfortunately for the famous old city, nine members of its council were opposed to, and only six in favour of progress and the telephone.

Telephone Extensions in Ayrshire.—The Kilbirnie Road Trustees have granted permission to the National Telephone Company, Limited, to extend its wires by Rowbank to Beith, thence to Glengarnock and Dalry, with a possible extension to Kilbirnie.

The German Telegraphs.—A Reuter's telegram from Berlin dated December 1st, stated that at a meeting that day of the United German Telegraph Company, shareholders representing 19,735 shares attended, and unanimously approved the sale of the company's lines to the German Government, as proposed by the directors.

South American Cables.—The cable ship *Roddam*, belonging to W. T. Henley's Telegraph Works Company, sailed from North Woolwich on the 1st inst., carrying 1,033 knots of cable, which will be laid in four sections between La Guayra, Curaçoa, St. Domingo, Puerta Plata, Mole St. Nicholas and Cuba. This cable is the first branch of a French system communicating with South America, the undertaking of the Société Française des Telegraphes Sous Marins. Mr. R. E. Peake is the engineer in charge of the expedition.

The Atlantic Cables.—The Central News states that the pool arrangement existing between the Anglo-American, the Direct United States, and the Western Union Telegraph Companies, is threatened with dissolution owing to serious disagreements which have arisen.

Cable-Laying off China.—We have received a copy of the *North China Daily News*, dated October 25th, in which is given an account of the laying of the submarine cables between Sharp Peak and Tamsui, and from Anping to Ponghou. The cable was taken out from Silvertown in the *Fee-cheu*, a new cable ship built at Sunderland for the Governor of Formosa, upon whom, we suppose, will devolve the duty of keeping the cables in repair. The work of laying the cables was commenced on September 27th, and was completed by October 13th. Mr. Joseph Rippon was in charge of the cable-laying, and he was assisted by Mr. H. P. Daley, of the Silvertown Telegraph Works, and by Captain Lugar.

Personal.—Mr. Elieson, whose labours in connection with the electric tramcars on the North Metropolitan line have somewhat undermined his health, has started for a month's trip to Italy. We trust that his rest will enable him to return with renewed vigour to the subject which he has made his own.

Lighting of Trains.—The *Detroit Free Press* assures us that the lighting of passenger cars on railroads has always been stupidly managed. But car builders are about to institute a reform in this matter, and by the use of electricity, or a more common sense arrangement of the lamps, it will be possible for passengers to read at night. We hope it may be so.

Electric Haulage.—Our readers know that in one of the Silesian mines electricity has been applied to the haulage. The comparative cost of the working forms the subject of an interesting paper in a French technical journal. The table is summarised by M. Lebreton thus :—Cost of electrical traction, per ton-mile, 2·0d. ; cost of horse traction, 2·5d. ; cost of traction by men, 4·1d.

Miners' Electric Safety Lamps.—The *South Wales Echo* says Mr. J. W. Swan paid a visit a week or so ago to the National Colliery, Wattstown, accompanied by Messrs. E. H. Watts, jun. (director), and Mr. G. W. Wilkinson (general manager), of the National Steam Coal Company. This company, and the other colliery companies under the management of Messrs. Watts, Ward and Co., have been the first firms to introduce miners' electric lamps in the United Kingdom. At present 200 of these lamps have been put into use at this colliery, superseding the Marsaut lamp, which was only recently introduced as one of the safest oil lamps extant. Mr. Swan visited the working places underground, and, in reply to questions, the colliers expressed their unqualified preference for the electric lamps over all oil lamps, because of their superior light, absence of smoke, and requiring no attention. The Edison-Swan Company is now manufacturing 2,500 of these lamps for Messrs. Watts, Ward and Company's collieries, and, when these are ready for use, not a single oil lamp will be allowed in any of their pits. Mr. Swan also exhibited and experimented underground with his new electric gas-detector, which is attachable to the miners' lamp, and will indicate the presence of fire-damp in much more minute quantities than can be detected by any oil lamp. Before leaving, Mr. Swan handed Mr. Gibbon, the resident manager, a contribution of £5 towards the Miners' Sick Fund in connection with the colliery.

Electrical Haulage Tests. — By an oversight, an error occurred in the article we published last week on electrical haulage at the Newcastle Exhibition. After the words (on page 563) : "the average work done on the rope on the up grade was," the figures should read as follows :—

$$\text{1st part} \quad \frac{442 \times 285}{33{,}000} = 3{\cdot}3 \text{ H.P.}$$

$$\text{2nd part} \quad \frac{504 \times 285}{33{,}000} = 4{\cdot}3 \text{ H.P.}$$

$$\text{3rd part} \quad \frac{704 \times 285}{33{,}000} = 5{\cdot}75 \text{ H.P.}$$

Boiler Contracts.—The Babcock and Wilcox Company has obtained a contract for six 124-horse-power boilers for the Imperial Continental Gas Association's electric light installation in Vienna. The same company will also supply the boilers for the 8,000-light Edison installation for Messrs. Gatti and others. The company has done some of the largest and most successful business ever transacted in America, and it appears likely to follow it up in this country.

The Maxim-Weston Company.—Mr. Hugh Watt, M.P., has addressed a circular to the shareholders of the Maxim-Weston Electric Company, setting forth the improved position of the company and the necessity for the additional capital which is being raised for the purpose of carrying out the work waiting to be done. He asserts that the company has been brought to a first position among electrical lighting companies in Europe with only about 10 per cent. of the capital at the disposal of competing companies.

By-products from Primary Batteries.—In the prospectus of the Electrical Company of Scotland, Limited, issued in Edinburgh in October, 1885, with the view of exploiting the Lalande battery, it may be seen that the oxy-sulphide of zinc was therein put forward as a product of great value, capable itself of yielding a profit to the company. It may also be calculated from the figures therein quoted that 12 Lalande may be worked at a cost of 8d. less than nothing. Mr. Hugh A. Fergusson, in his reply to Mr. Bennett's letter, states that the Lalande proprietors do not *now* regard the sulphide as important, for the expectations regarding the sale of it have not been realised. He also hints at a new and very valuable product to be shortly produced. The Scotch company did not succeed ; but supposing it had been launched, what would the shareholders be saying to-day about the sulphide statements contained in the prospectus ? Are predictions of the sale of the new product to be trusted any more than those concerning the sulphide ? They could scarcely be more precise and positive.

The Electro-Harmonic Society's "Ladies' Night."—On the evening of Friday last the second concert of the 1887—88 season took place at James's Hall. The audience showed a marked increase over the last "ladies night," and included many faces well known to the electrical world. The programme, which was of a high-class nature, had for its vocal exponents Madame Worrell, Miss Emily Foxcroft, the daughter of a gentleman long known to telegraph engineers, Mr. Henry Guy, Mr. G. W. Forington, and Mr. Herbert Schartau, and the efforts of one and all of these left but little to be desired. The instrumental items were supplied by Mr. T. E. Gatehouse, who played the "Andante and Finale" of Mendelssohn's violin concerto, and an "Aria and Gavotte" from a suite by Vieuxtemps, and Mr. Alfred Izard, who performed a "Study in C," by Rubinstein, and played the piano accompaniments throughout in his usual refined and masterly manner. A new Jubilee song, entitled, "Victoria Regina, D.G.," written and composed by Mr. C. E. Spagnoletti, one of the most active members of the society, and a direct descendent of a very famous musician, was finely given by Mr. Forington. The words are written in acrostic form, and the music, notwithstanding its simple style, is nevertheless of a manly kind, and, in the hands of a vocalist of Mr. Forington's calibre, may be made very effective. Altogether, the concert may be reckoned as a pronounced success, and it is gratifying to be able to announce that the elected members of the society now number 200, and that several more gentleman are awaiting election at the next meeting.

Something Wrong Somewhere.—A slight accident took place on Sunday at the Theatre de la Port Saint Martin, Paris. In the third act a panic occurred in the auditorium. An odour of burning being apparent, a certain number of persons arose and rushed towards the exits. The performance was interrupted for some time : the actors wondering whether it was in the auditorium, and the audience whether it was on the stage. This is what had happened, says *l'Intransigeant* of the 30th ult., the odour of burning proceeded from a conducting wire, the insulating covering of which had taken fire under the influence of excess of current. After a few minutes' delay, the public returned to the auditorium, and the actors were enabled to continue their performance ; but where were the safety fuses ?

Oppermann Electric Lighting and Manufacturing Company, Limited.—We are informed that it is not the intention of the directors of the Oppermann Electric Lighting and Manufacturing Company, Limited, to proceed to allotment. Lord Edward Spencer Churchill and some of the promoters of the Oppermann Company will start a new Electric Lighting and Manufacturing Company, which will carry on business at Blockley, in Worcestershire. Mr. C. J. T. Oppermann will not be connected with this company.

The Austrian Bell Telephone Patent Annulled.—A very important decision with reference to the Bell telephone patent in Austria has recently been given in the latter country. The ground of the decision is that the invention was already known in Austria at the time the patent was granted. Claims 13 and 15 of the patent, which claims practically constituted a monopoly of the telephone, had been annulled as regards Austria-Hungary in March, 1885, in pursuance of a petition made by Mr. O. Schaeffler, of Vienna, in December, 1882. Moreover, on the demand made in December, 1884, by the Vienna Private Telegraph Company it was decided in Lower Austria in April, 1886, that the methods claimed under clauses 1 to 10 of the Bell patent were invalid. As a consequence, the employment of the telephone became equally free in Austria-Hungary since March, 1885. The latest decision of the Minister of Commerce, dated October 28th, 1887, was called forth in consequence of a complaint made by the Consolidated Telephone Company of London; this decision annulled ten of the most important claims of Bell, and destroyed the whole value of the patent. According to the *Neue Freie Presse*, the claims relating to the transmission of articulate sounds by the induction produced by the deformation of iron plates would be annulled. The same is the case with reference to "the employment of resonators, and the combination of a steel magnet with a prolongation of soft iron surrounded by a bobbin." In fact, the "methods for the production of musical sounds by means of undulatory electric currents, and the production of a continuous undulatory current by the oscillations of a body capable of inductive action, or of a bobbin in the neighbourhood of such a body," are also free to the public.

The Société Belge d'Electriciens.—The report of M. Charles Mourlon, the secretary of this society, for the year 1886—1887, has recently been published. During the year the society has been affiliated with the Société des Ingenieurs et Industriels, of Brussels, with the privilege of holding meetings in the rooms of the Palais de la Bourse. Meetings have been held every month in the year. Amongst other communications one had been received from M. Somzée, relative to an action which had been brought by him against M. Picard on the question of the priority of the invention of incandescence lamps. MM. Lefebvre and E. Goethals had contributed communications on telephones. Results of experiments on batteries had been given by M. Courtois. M. Gerard had contributed a paper on magnets. A number of other papers had also been read and received. The president for the year was M. Bede, Engineer, Conseiller Communal of Brussels, and late Professor at the Liege University. The Society, which was founded in 1883, is in a very flourishing condition, and has been doing excellent work.

An Antifriction Alloy.—We are informed by the Phosphor Bronze Company that the price of its "Vulcan antifriction alloy" remains unaltered notwithstanding the great advance in the price of tin which enhances in proportion the cost of *genuine* Babbitt's metal. This alloy is about one-third the present price of Babbitt's *genuine* mixture, and practically answers the same purposes. *Vulcan* is the registered trade mark for certain specialities manufactured by the Phosphor Bronze Company.

Electric Communication with Lightships.—At a meeting of the Dover Town Council on Wednesday, it was decided to forward a petition to the Queen, praying that immediate steps may be taken to establish electric communication between the Channel lightships and the shore. The recent disasters in the Channel were instanced as showing the urgent necessity of such communication, the *W. A. Scholten* disaster occurring within a very short distance of the Goodwin Sands Lightship. It was stated that Ramsgate, Margate, Deal, Sandwich and other coast towns had adopted similar memorials.

Lecture on the Electric Telegraph.—On Thursday, December 1st, at the Fine Art Gallery, Bournemouth, the Rev. G. H. West, M.A., in the chair, Mr. William Lynd delivered a lecture before the Bournemouth Society of Natural Science on "The Electric Telegraph." Through the kindness of Mr. C. H. B. Patey, C.B., the secretary of the Postal Telegraphs, Mr. Lynd was able to show the telegraph actually at work. The lecturer manipulated a Morse printer, and the telegraph superintendent, Mr. F. A. K. Hounsell, officiated at the sounder. There was a very large and a highly appreciative audience. At the close of the lecture, the president of the society, the Rev. G. H. West, proposed a hearty vote of thanks to Mr. Lynd, which was warmly applauded by the audience.

Elieson's Electric Locomotives.—Since August 1st the Elieson cars have run a total distance of over 20,000 miles in the most perfect and punctual manner. Statements of the number of passengers carried have been supplied by the North Metropolitan Tramways Company, which conclusively prove that the public prefer this mode of conveyance to horse cars; and we shall not be surprised, says the *Metropolitan*, if an outcry be shortly raised against the use of horses for hauling heavy cars, now that it has been clearly proved that the problem of drawing them by electricity has been successfully solved, and that it is unattended by the risks, dirt, smoke, and offensive gases which appear inseparable from the use of steam.

Electric Lighting in Spain.—The largest independent electric light installation in Spain, says *Industries*' Madrid correspondent, will be that of the Royal Italian Opera House, which is being carried out by the Schuckert Company. There will be about 1,500 glow lamps, and a dozen Krizik arcs. The town of Albacete, which has a population of about 20,000, and which has hitherto been lighted by oil, is adopting the electric light for private and public lighting, 16 C.P. glow lamps being employed. The installation will be ready in a few weeks. The municipality of Bilbao, which has some surplus engine power at its water works, intends to utilise it for lighting the principal thoroughfare of the town by means of 32 arc lights. Schuckert dynamos will be used.

Flying High.—We are informed that those gentlemen who a few weeks since were exploiting an electrical tramcar on the Richmond-Kew line of the West Metropolitan Tramway Company, have actually arranged with the Metropolitan District Railway Company to construct a locomotive to operate on that line. Mr. Phillippart is a wonderful man.

Edison and Swan United Electric Light Company v. Shippey Brothers.—In the litigation between these parties the plaintiff company, on Wednesday, succeeded in getting the order of the court for the deposit by the defendants of security for a proportion of the costs of the action, the plaintiffs having been hitherto successful.

Errata.—Metallic circuits for telephone lines, last week's issue. Page 561, column 1, line 53, for "distributing," read "disturbing." Page 561, column 2, line 8, for "circling currents," read "circling current."

Loeb Chemical Electric Light Company.—The courts were occupied in the early part of this week with proceedings connected with the winding up of this company. Objections were raised by certain creditors to the manner of the winding up, but eventually these were withdrawn upon an undertaking being entered into by Mr. Burroughes to take over the assets of the company in consideration of the debentures he held, paying out of the proceeds 5s. in the pound and £50 towards the costs of the litigation; if the costs exceed £50 the balance will be deducted from the dividend.

Brussels Exhibition of 1888.—Rumours have been lately current to the effect that the opening of the Exhibition has been indefinitely postponed. The management, however, emphatically contradicts these reports and announces that the Exhibition will be inaugurated on the first Saturday of next May. It is stated that the Executive Committtte has received 500 applications for space from foreign countries. In view of the delay which might arise through late entries, it has been decided to refuse any applications arriving after the 1st of January next. Among the countries exhibiting, Germany has secured 10,000 square metres of space, Holland 9,000, and England, exclusive of British India, 20,000. Russia sends 250 exhibitors. The United States and Austria will be largely represented, but France and Belgium will make but a poor show, France having refused to take an official part in the Exhibition.

Schanschieff's Primary Battery. — Mr. Perry F. Nursey thinks that if he had seen—or rather the *Times* thinks that if Mr. Nursey had seen—the Schanschieff battery before reading his recent paper before the Society of Engineers, he would have been able to make it the one exception to his sweeping rule, that no primary battery which he had examined met all the conditions that were required for domestic illumination.

Society of Telegraph-Engineers and Electricians.—The council, we are informed, has decided to change the title of the society to "The Institution of Electrical Engineers."

Popular Science Lectures.—Prof. W. Lant Carpenter, B.A., B.Sc., &c., delivered the first of a course of three lectures on "Electricity in the Service of Man," in the grand hall of the International College, Finchley Road, N.W., on Thursday last week to a crowded audience.

A German Electric Locomotive. — According to *Industries* a new electric locomotive has been built by the firm formerly known as Schwartzkopf & Co., of Berlin, and public trials are announced to take place on the tram line between Weidendammer-Brücke and the Weddingplatz. The motor is in design similar to a Gülcher dynamo, is speeded at 300 revolutions, and connected with the axles by spur gearing. Electric power is supplied by a battery of E.P.S. accumulators, giving 200 volts and a maximum rate of discharge of 40 ampères. The total storage capacity is 300 ampère-hours, and the estimated speed is 7½ miles per hour.

Small Electro-Motors.—A new departure has been taken by Messrs. Siemens and Halske, who are now building small electro-motors from $\frac{1}{10}$ H.P. to 2 H.P. capacity, for use in private houses which are served by one or other of the electric supply stations in Berlin.

An Electric Pilot Engine.—The *Times* Vienna correspondent says :—An invention of Herr Gieszl, of Brünn, for preventing railway collisions, is being highly spoken of among Austrian engineers. It consists of a pilot engine, or safety lorry, worked by electricity, and running at some distance in front of the train. It stops the train automatically, and runs at any speed. From a dynamo-electric machine on the engine of the train a current is conducted through the rails to the pilot engine. The engine-driver has the lorry perfectly under his control, and the distance between it and the engine may be varied to suit curves or other conditions of the line. The pilot engine is fitted on the exterior with a number of glass vessels, one or more of which must be broken if they encounter any obstacle. The glass vessels contain mercury contacts, and as the breakage causes an interruption of the current the vacuum brakes of the train are automatically applied. Two express trains running at full speed towards each other would thus be automatically stopped by the collision of their respective pilot engines.

The Liverpool Jubilee Exhibition.—The executive council of the Liverpool Jubilee Exhibition of 1887 have issued to the guarantors a circular, in which they state that the approximate result of the receipts and expenditure of the exhibition is to leave a balance of £50,897 to be provided for, while the building and other assets cannot be estimated to realise more than £15,000. The whole of the guarantee of £34,289, after deducting the amount paid on account of last year's International Shippers' Exhibition, will be required. The executive council, therefore, make a call upon the guarantors.

Who is He?—The Royal Scottish Society of Arts recently awarded a prize to Mr. Moore, of Belfast, for a paper on "Improvements on the Marine Compass and its Adjustment." Upon this Mr. Bottomley, and a little later, Sir William Thomson, wrote to certain gentlemen asserting that Mr. Moore's system was an absurd one, and that it was a pity someone did not point out to the Society that the plan was simple nonsense. This got to the ears of Dr. Sang, the secretary of the Society, and now he cannot rest quietly under "the sentence of discredit so officiously pronounced by Sir William Thomson," and wants some information as to "his status as a judge, the extent of his jurisdiction, the solicitor for his intervention, and the soundness of his judgment." Mr. Moore suggested the use of movable correctors for the adjustment of the compass for heeling error.

Electricity for the St. Catherine's Lighthouse.—It is intended to furnish the lighthouse at St. Catherine's, Isle of Wight, with a new and most powerful electric light, capable, it is said, of projecting a ray equal to six million C.P., which will be able to pierce the darkness for a distance of 50 miles. Three of Robey's compound engines are to be supplied, and the current will be generated by two of De Meriten's magneto-electric-machines. Around a dioptric light will rotate, by means of clockwork, a drum, consisting of eight panels of vertical lenses, by means of which the continuous and divergent streams of light from the fixed portion will be concentrated so as to constitute distinct beams successively reaching the eyes of those at sea as the panels pass in turn before them. The engines used for working the electric machinery can also be employed for compressing the air for the fog signals. An engineer will be stationed at St. Catherine's, and under him are to be four keepers with an occasional assistant. The houses of the various officials are to be connected by telephonic or electric bell communication. The projected improvement will be greatly welcomed by all mariners cognisant of the dangers to be encountered at the back of the Isle of Wight.

Cremation in America.—The first young girl to be cremated in America, we read, was Alida Weissleder, the daughter of the superintendent of the Brush Electric Light Company, Cincinnati, aged nine.

The Smoke Problem.—A Vienna engineer named Fischer has just taken out a patent for a new smoke-abating process. He proposes, by means of electricity, to condense the solid part of the smoke as it arises from the coal, the carbon thus solidified falling back into the furnace.

Edinburgh Royal Society.—The first meeting of the session was held on Monday evening, Lord M'Laren, Vice-President, in the chair. The chairman, in an opening address, said the condition of the society was entirely satisfactory. The Victoria Jubilee Prize was presented by the chairman to Sir William Thomson, the prize being awarded for a valuable series of papers on hydro-kinetics.

Slaughtering by Electricity.—Recently some experiments have been made in St. Petersburg with the idea of slaughtering cattle by electricity, the results of which have been highly satisfactory—death being in all cases instantaneous.

To our Readers.—We regret that we shall not this week be able to publish the continuation of Dr. Lodge's "Modern Views of Electricity." Messrs. Macmillan, through their solicitors, demand their discontinuance at the moment we are going to press, and we have no alternative but to accede to their request; we hope, however, that arrangements may yet be made which will enable us to complete the series. At present, we can only refer our readers to *Nature* of December 1st for the last contribution to the subject. We were under the impression that it was not unusual amongst journalists to reproduce articles of interest from weekly journals so long as the source was acknowledged, as it was in this case, but if we have prejudiced the interests of Messrs. Macmillan we have no hesitation in expressing our deep regret, and also in assuring them that our sole object was to make Dr. Lodge's admirable articles more widely known to electrical readers.

Legal.—We are informed that in the action Sharp and Kent *v.* D'Humy, which was to recover £100 for carbon plates supplied for a primary battery, a counter claim of £1,000 being brought for damages sustained through the defective character of the plates, judgment has been given for the plaintiffs.

The Railway and Electric Appliances Company, Limited.—The creditors of the above-named company are required, on or before the 15th day of January, 1888, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors, if any, to Mr. Andrew Williamson, of No. 149, West George Street, Glasgow, or to Mr. James Worley, of No. 27, Leadenhall Street, London, E.C., the liquidators of the company.

Royal Society.—Amongst the papers announced to be read at the meeting of the Royal Society on Thursday evening, was one on the "Photometry of the Glow Lamp," by Captain Abney, F.R.S., and Major-Gen. Festing, F.R.S.

Electric Railways.—Mr. W. Hamilton, of Herne Bay, has written to the *Kentish Gazette* proposing the construction of an electric railway between Canterbury and Herne Bay, increased means of transit being greatly needed, whilst the traffic is not large enough to support an ordinary line of railway. He thinks an electric line could be built and equipped for £30,000, and that the annual cost of maintenance would not be more than £550. The "takings" necessary to make the line pay, he estimates, would be about £3,000 a year.

Electrical Transmission of Power.—The Municipality of Geneva is considering a scheme for utilising the motive power of the Rhone. A report on the subject has just been published, together with a series of resolutions for certain credits to provide for the extension of the distribution of power, to supply electric light to the theatre, and to meet the expenses incurred in the construction of sewage collecting works. Already, by means of turbines and pumps, the Municipality not only distributes water throughout its own domain, but also to 15 neighbouring communities. In addition, by means of 175 motors, it supplies power in quantities varying from half a horse to 70 horse to 145 manufacturers or artisans in their own establishments, homes, or workshops, within a circle having a radius of not less than a mile and a quarter from the central station. Hitherto the method of hydraulic transmission has been adopted. But in considering whether it would be best to supply hydraulic power to the theatre for conversion into electricity there, or to supply the electricity direct from the source of the power, the Council has decided to combine a system of electrical transmission with its hydraulic system, because it is found that in the case of many workshops—such as those of the clock and watch makers—situated in the upper storeys of buildings, as well as in the case of the theatre, there will be a saving of power by the electrical method.

Hering's Secondary Battery.—In a patent recently issued to Mr. Carl Hering, of Philadelphia, the inventor describes a new method of preparing the plates of secondary batteries. When the plate has been prepared with the plastic active material, it is usually allowed to dry and become hard before being formed. When it is immersed in the liquid to be formed, the active material rapidly absorbs the liquid, and is liable to be disintegrated and loosened from the plates. In order to avoid this action, Mr. Hering employes a binding material, consisting of a stable lead salt, which will not dissolve in the sulphuric acid of the cell, and being a lead salt it is ultimately converted into lead peroxide or metallic lead.

NEW COMPANY REGISTERED.

Portland Electric Light Company Limited. — £45,000 in £5 shares. Objects: To enter into contracts for electric lighting, and for the supply of electric energy for power or transmission. Signatories (with one share each), G. E. Cockburn, Sudbury, Harrow; Arthur Williams, 11, Bisham Gardens, Highgate; F. J. Oliver, 96, Holly Street, Dalston; Robert Hunter, 80, Paxton Road, Chiswick; P. W. Felbrigg, The Bank, Highgate; W. A. Fenn, 16, Hunsden Road, Hatcham; C. Mason, 6, Elm Grove, Cricklewood. The signatories are to nominate the first directors. Qualification, 20 shares; remuneration, £150 per annum. Registered 30th ult., by Robinson and Turnbull, 4, Mitre Court Chambers, Temple. Registered office, 48, Osnaburgh Street, N.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

London and Globe Telephone and Maintenance Company, Limited.—The final winding-up meeting of this company was held on the 29th ult., when an account was laid before the shareholders showing the manner in which the winding-up of the company had been conducted and its property disposed of.

Pilsen, Joel and General Electric Light Company, Limited.—The annual return of this company made up to the 24th ult., was filed on the 2nd inst. The nominal capital is £56,225, divided into 28,000 shares of £2 each and 100 shares of £2 5s. 24,483 of the former shares are allotted and £1 5s. per share has been called; the 100 shares of £2 5s. are fully paid up. The calls paid amount to £31,708 15s. Upon 3,517 shares forfeited the sum of £880 has been paid.

Chatham, Rochester and District Electric Lighting. —The statutory return of this company made up to the 28th ult. was filed on the 2nd inst. The nominal capital is £10,000 in £5 shares. 712 shares have been allotted and £2 per share has been called up. The sum of £791 has been received in respect of calls, and £15 in anticipation of future calls. The calls unpaid amount to £633. Registered office 22, High Street, Chatham.

H. C. Bull & Co., Limited (electricians and manufacturers of aluminium, magnesium, &c.).—The statutory return of this company made up to the 4th ult., was registered 24th ult. The nominal capital is £1,000,000 in £10 shares. 29,557 shares have been taken up and the full amount has been called thereon. 29,500 shares are considered fully paid, and upon the remaining shares the sum of £320 has been received, £250 remaining unpaid. Registered office, 31, Poultry, E.C.

South Metropolitan Electric Supply Company, Limited.—The registered office of this company is situate at 169, Winchester House, Old Broad Street.

Orient Electric Light Company, Limited. — The registered office of this company is at 83, Lombard Street.

CITY NOTES.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended September 30th, of 2s. 6d. per share, tax free, payable on January 14th.

The Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended September 30th, payable on the 23rd inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of November was 3,343, estimated to produce £3,000, against 3,077 messages, producing £2,580 in the corresponding month of last year. The receipts for the month of August, estimated at £2,250, realised £2,280.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 2nd were £3,870, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th November are £2,627, as compared with £2,357 in the corresponding period of 1886.

The Great Northern Telegraph Company, Limited. The receipts for November, 1887, £22,000; from January 1st to November 30th, 1887, £242,880; corresponding months, 1886, £239,000; and of 1885, £264,440.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November were £2,115, against £1,876 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for November amounted to £39,000, and to £36,739 for November, 1886.

The Eastern Telegraph Company, Limited. The receipts for November amounted to £55,454, and to £50,817 in the corresponding month of 1886.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended December 2nd amounted to £4,817.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending November 30th are £1,225.

NEW PATENTS—1887.

16087. "Contact maker for use with coin-freed apparatus." J. S. FARMER. Dated November 23.

16120. "Voltaic batteries." E. TYER. Dated November 23. (*Complete.*)

16128. "Mechanical telephones." W. H. MUNNS. (Communicated by J. B. Sunderland and D. M. Monjo.) Dated November 23.

16134. "Voltaic batteries." T. J. JONES. Dated November 23.

16185. "Electric meters." W. J. S. BARBER-STARKEY. Dated November 24.

16217. "Automatically conveying and delivering letters and small parcels by electricity." F. C. ALLSOPP. Dated November 25.

16228. "Arc lamps for electric lighting." W. T. C. WARD, E. W. W. ADCOCK. Dated November 25.

16252. "Arc lamps." J. KENT. Dated November 25.

16296. "Primary and secondary galvanic batteries." A. F. ST. GEORGE, C. B. BONNE. Dated November 26.

16304. "Making plates for electrotyping." W. R. LAKE. (Communicated by the Hoke Engraving Plate Company.) Dated November 26.

16305. "Voltaic cells." H. C. DONOVAN, T. WEATHERALL. Dated November 26.

16324. "Electro-mechanical striking gongs." F. T. SCHMIDT. Dated November 28.

16325. "Electrical switches and cut-outs." F. T. SCHMIDT. Dated November 28.

16333. "Mechanical appliance adjustable for electric lights." A. B. O'CONNOR, G. W. BUTTERFIELD. Dated November 28.

16342. "Phonographic apparatus for recording and reproducing vocal and other sounds." G. L. ANDERS. Dated November 28.

16351. "Electric belts." A. OWEN. Dated November 28. (*Complete.*)

16376. "Electric arc lamps." C. B. and R. D. NOBLE. Dated November 29. (*Complete.*)

16378. "Autographic telegraphs." H. J. ALLISON. (Communicated by the Writing Telegraph Company.) Dated November 29.

16384. "Tablets or recording media for use in graphophones." J. G. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated November 29. (*Complete.*)

16398. "Automatic machines for the supply of liquids on draught by electrical and other means." B. W. WARWICK. Dated November 29.

16406. "Telegraphic transmission and apparatus therefor." P. B. DELANY. Dated November 29. (*Complete.*)

16424. "Telegraphic instruments." W. P. THOMSON. (Communicated by C. G. Burke.) Dated November 29. (*Complete.*)

16455. "Secondary or storage batteries." T. THAME. Dated November 30.

16458. "Electric telephones." A. A. CAMPBELL-SWINTON. Dated November 30.

16473. "Electrical signalling device for railway purposes." S. S. BROMHEAD. (Communicated by S. T. Street.) Dated November 30. (*Complete.*)

16474. "Automatic machines for the supply of electricity for medical and other purposes." B. W. WARWICK. Dated November 30.

16489. "Producing power for mechanical purposes for generating electricity." A. MELVILLE. Dated November 30.

16537. "Applying electricity to propel vehicles, &c." F. WYNNE. Dated December 1.

16554. "Electric apparatus for indicating distant water levels and similar purposes." G. BINTER. Dated December 1. (*Complete.*)

16558. "Measuring and regulating electric currents." A. WRIGHT. Dated December 2. (*Complete.*)

16559. "Measuring electrical currents." A. WRIGHT. Dated December 2.

16565. "Electrical measuring instruments." E. THOMAS. Dated December 2.

16583. "Regulating electric arc lamps." F. C. PHILLIPS. H. E. HARRISON. Dated December 2.

16584. "Controlling and regulating electric-motors." F. C. PHILLIPS, H. E. HARRISON. Dated December 2.

16603. "Electric lamps for velocipedes." A. J. BOULT. (Communicated by R. Weber.) Dated December 2.

16623. "Dynamo-electric generators." W. T. GOOLDEN, L. B. ATKINSON. Dated December 2.

16669. "Secondary battery combined with a miners' lamp." M. BAILY, J. WARNER. Dated December 3. (*Complete.*)

16678. "Laying underground electric conductors." E. W. BECKINGSALE. Dated December 3.

16696. "Generating electricity for temporary purposes." T. R. WESTON. Dated December 5.

16701. "Detecting irregularities in passage or delivery of letters and tampering with envelopes after postage." C. J. EYRE. Dated December 5.

16709. "Electrical generators." T. A. EDISON. Dated June 13,

16717. "Electro-therapeutic apparatus." P. A. NEWTON. (Communicated by F. J. Kneuper.) Dated December 5.

16728. "Making incandescent electric lamps." A. HEINTZ. Dated December 5. (*Complete.*)

16734. "Carrying money or goods to or from different parts of shops, &c." H. H. LAKE. (Communicated by W. R. Cole and F. H. Edwards.) Dated December 5. (*Complete.*)

16772. "Electric bells. J. A. MACDONALD. Dated December 6.

16790. "Dynamo-electric machines." S. C. HANBERG. Dated December 6.

16807. "Incandescent electric lamps." D. URQUHART. Dated December 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

13761. "An improved method of constructing and regulating electric arc lamps," W. ROWBOTHAM and F. S. WORSLEY. Dated October 27. 8d. Claims:—1. The described method of regulating the arc of an arc lamp by the attractive influence of two solenoid coils on two determined proportioned cores of the same length, one being all iron in a brass tube and the other about half iron and half lead, or any other non-magnetic body in a brass tube, arranged in such a manner that when the current passes through the lamp circuit both cores are affected by the attractive influence of the solenoid coils, but just before the full arc is established the core composed of iron or lead is not affected by the attraction of the solenoid, the magnetic body being out of range of the attractive force. So enabling the full arc to be struck independently to its full extent with great promptitude by the attractive force of the series solenoid on its core. 2. The described method of regulating the arc of an arc lamp by two solenoids and cores arranged in such a manner that the shunt core is in the neutral part of the solenoid at time of feed, and so allowing the series core to regulate the arc. 3. The construction of electric arc lamps with regulating solenoids, having tight-fitting cores of equal length, the one being wholly of iron, the other being half iron half lead, both enclosed in brass tubes, attached to each other by means of a chain over a grooved pulley, fixed on a spindle having a pinion over which passes a flexible rack, or free to move on a spindle, controlling by means of a brake a fixed wheel or wheels on said spindle, having a pinion over which passes the said flexible rack, having positive and negative carbon holder attached one at each end, substantially as described.

14974. "Improvements in electric safety lamps for use in mines and other places. M. SETTLE. Dated November 18. 8d. Claim:—In an electric safety lamp, a flexible or resilient diaphragm having the lamp attached to one side and a movable contact piece or pieces to the other, such diaphragm forming the top or other movable portion of an air and liquid tight casing or vessel, and being acted upon by the pressure of a liquid or other fluid inside the vessel in combination with a fixed contact piece or pieces outside the said casing or vessel; the pressure of the liquid or other fluid serving to keep the contact pieces together so as to complete the electric circuit and thus maintain the light in action and the escape or absence of the liquid or other fluid from the casing or vessel withdrawing the pressure and allowing the elasticity or resiliency of the said diaphragm to draw the said contact pieces asunder, and thus extinguish the light substantially as hereinbefore described and illustrated by the drawing.

15230. "Improvements in field magnets." L. HANSON. Dated November 23. 6d. The inventor employs a shell from any suitable material, which shell he covers with soft iron wire wound around the said shell in as many layers as may be thought desirable. There is 1 claim.

16823. "Improvements in electrical batteries and in the manufacture of depolarising bodies to be used therein." E. BARBIER and M. LECLANCHE. Dated December 22. 8d. Consists of an agglomerate formed of peroxide of manganese, 40 per cent.; graphite, 44; pitch (brai gras), 9; sulphur, $\frac{3}{8}$; water, $6\frac{3}{8}$; total, 100. The claims are 4 in number.

PROCEEDINGS OF SOCIETIES.

Physical Society, November 26th, 1887.

Dr. BALFOUR STEWART, President, in the Chair.

Mr. Asutosh Makhopadhyay, M.A., F.R.S., was elected a member of the Society.

The following communications were read: "On the Analogies of Influence Machines and Dynamos," by Prof. S. P. THOMPSON, D.Sc. The author pointed out that in nearly all influence machines there are two stationary parts ("inductors") electrified oppositely, which are analogous to the field-magnets of dynamos, and a revolving part carrying "*sectors*," which correspond to the "*sections*" of an armature. To prevent ambiguity, Prof. Thompson proposes to call the inductors "*field plates*" and the revolving parts as a whole an "*armature*." In the Wimshurst machine both field plates and armature rotate, and each act as field plates and armature alternately.

In the two field plate influence machines there are four and sometimes six brushes. Two of these act as potential equalisers, two as field plate exciters, and the remaining two (if any) are generally placed in the "discharge" or external circuit.

The Holtz machine having only four brushes, two serve the double purpose of potential equalisers and discharge circuit, and this machine excites itself best when the discharging rods are in contact. In this respect it resembles a series dynamo which only excites itself when the external circuit is closed, but on opening the circuit (say by inserting an arc lamp) produces remarkable effects. So in the Holtz machine on separating the discharging knobs a shower of sparks result.

The Toepler machine (made by Voss) having six brushes resembles a shunt dynamo and excites itself best on open external circuit. Analogies were traced between Thomson's replenisher and the Griscom motor.

Armatures of influence machines, as in dynamos, can be divided into ring, drum, disc and pole armatures, and examples of each kind were mentioned. The "Clark gas lighter" is a good example of a drum armature, and a diagram showing the internal arrangements was exhibited.

An example of an analogue to the compound dynamo was mentioned as existing at Cambridge in the form of a Holtz machine, believed to have been modified by Clerk-Maxwell.

Another analogue with dynamos is found in the displacement of the electric field when the armature is rotated, just as the magnetic field of a dynamo is shifted round in the direction of rotation.

Further analogies are traced between "critical velocity" of dynamos (which depends on the resistances in the circuit) below whch they do not excite themselves, and a similar critical velocity of influence machines, *e.g.*, in a Wimshurst or Voss machine, the potential equalising circuit should have a low resistance if they are to excite themselves readily.

Self-exciting dynamos excite better when the iron is bad and retains the magnetism; and influence machines excite better when the field plates are made of paper or such substance as can well retain a residual charge.

Finally an apparatus analogous to Thomson's "water dropping accumulator" was exhibited, in which an electric current was generated by mercury falling down a tube between the poles of a magnet.

Prof. AYRTON pointed out an historical analogy between the inventions of the influence machine and the dynamo; for as Varley anticipated Thomson in the invention of the self-exciting influence machines, so Hjorth anticipated Varley, Wheatstone and Siemens in the invention of the self-exciting dynamo.

Dr. FLEMING considered that just as all influence machines may be looked upon as descendants of Volta's "electrophone," so dynamos are of Faraday's "coil and magnet."

"On the effect produced on the thermo-electric properties of iron when under stress or strain by raising the temperature to a bright red heat." By Mr. HERBERT TOMLINSON, B.A. In June last the author described some remarkable "Effects of change of temperature on twisting and untwisting wires which have suffered permanent torsion," of which the present paper is a continuation. It is found that at or about the critical temperature (a bright red heat), mentioned in the previous paper, a sudden E.M.F. is generated at the junction of two iron wires, one of which is under stress or has suffered permanent strain, and the other in an unstrained state. By suddenly bringing a red hot iron wire in contact with cold iron, an E.M.F. of about $\frac{1}{10}$ volt is produced. If copper be used the E.M.F. is about $\frac{1}{3}$ volt. The author also showed that if one part of an annealed iron wire is heated to a bright red by a Bunsen flame, an E.M.F. is generated if the position of the flame is slightly altered, the direction of the E.M.F. depending on the direction of the displacement.

Prof. AYRTON believed the high E.M.F. exhibited by hot and cold copper was really due to oxide of copper, and

Prof. S. P. THOMPSON said that different effects could be produced by using the oxidising or reducing parts of the flame in heating the wire.

CORRESPONDENCE.

The Society of Telegraph-Engineers and Electricians.

The necessity for provincial branches of the Society of Telegraph-Engineers and Electricians has long been felt, and, now that the subject has been re-opened, I trust active steps will be taken to establish at least one in Scotland.

It may be true that the pearls derivable from the hard heads of Scotchmen are of but small value in the eyes of certain people, but we should be led to take a keener interest in subjects electrical—in the welfare of each other—and make our influence felt by sending delegates to an annual conference.

The lukewarmness exhibited by young provincial electricians is probably due, not so much to the difficulties experienced in obtaining the necessary number of recommendations for admission to the society, as to the want of opportunity to take an active part in its affairs—to participate in the advantages offered to members resident in or near London—and to the fact that all, or nearly all, that is worth knowing of the society's preceedings are to be found in the more important technical journals, and that, too, while the subjects are quite fresh.

Mr. Bennett says the range of subjects is too limited, yet he proposes that all papers presented to provincial societies be sent to London for approval before being read. I venture to suggest that every local branch accept contributions from its members, read and discuss them, and only send to the editing committee such as are considered by the local committee as deserving of that honour. Of course, such papers could be supplementary to those sent from London to be read.

The question of circulating the books of the library was discussed in your columns some years ago, and, perhaps, if members were now to show a desire to obtain the books, the rule which has hitherto prevented their circulation could be revised.

With regard to expenses incurred by the branch societies, it should be distinctly understood that they are to be met locally, otherwise, there will be incessant complaints of extravagance, partiality, or niggardliness. In short, let us have "Home Rule."

The obstacles to be overcome in the formation of a Scotch branch are not likely to be very serious, and we are quite accustomed to put a "Stoot heart to a stey brae."

Fareham.

Scientific Discussion.

When I was this evening at the Society of Telegraph Engineers and Electricians, in the discussion on the papers of Professors Fleming, Ayrton and Perry, my chief object was to ask Professor Ayrton whether the repeated extension and contraction of the wire in his

volt-meter had not some effect on the molecular structure of the wire and so impaired the constancy and veracity of the indications; but I also made a few introductory remarks about Professor Fleming's volt and watt-meters, stating it to be my opinion that although well adapted for the laboratory, I would not look upon it as the future workshop ampère-meter, since I could not see any advantage over Siemens's electro-dynamometer, as it had the faults of the latter, whilst it certainly would be more subject to self-induction; and being under time limit imposed by the chairman, I concluded by saying that I supported the many remarks upon it which had fallen from previous speakers. Professor Fleming in his reply, stated that I had "declared his instrument as useless, and by such sweeping assertion meant to criticise it." I might have stood up and denied ever having said so; but I have no desire to wrangle with Professor Fleming either at a meeting or in a correspondence, but merely protest against such a distortion of my remarks, which is unbecoming of a professor.

C. Godfrey Gumpel.

December 1st, 1887.

Tensile Strength of Electrolytic Copper.

While the late action of Elmore *v.* Pirrie was being tried before Mr. Justice Kay, Messrs. Goodwin & How, civil engineers, of Westminster, who were engaged in the case, called my attention to a statement in my work "Electro-Deposition," relating to the tensile strength of copper, which is erroneous and misleading, and I shall esteem it a great favour if you will kindly allow me to correct that statement in your widely-circulating columns. On page 145 of my book, a comparison is drawn between the tensile strength of sheet copper, as manufactured by the ordinary process, and copper deposited by the Hallett-Elmore dynamo, which would lead readers to believe that the latter material broke under the tensile strain equal to 32 tons per square inch of the original area, and at the same time elongated 38·3 per cent. Now, this is palpably untrue, and it is my duty to point out how it was that such a statement found its way into the pages of the book referred to. In 1885, while seeking for practical data for the work, I paid a visit to Mr. Elmore's establishment, amongst others, and requested him to furnish me with any information of what he was doing in electro-deposition that would interest the readers of such a work, telling him at the same time that I wanted nothing but *fact*. I had my reasons for urging this very strongly. He called my attention to his electrolytic copper, showed me several of Mr. Kirkaldy's certificates of the results of his testing experiments, and handed me a statement, which I afterwards published in my book, believing (or hoping) at the time that he would not have ventured to give me, for publication, matter that was either misleading or untrue. In this statement, Mr. Elmore had taken from Mr. Kirkaldy's certificate the stress per square inch of the *fractured* area, and coupled that with the elongation, while the certificate referred to shows that the copper stood 15·2 per square inch of *original* area and elongated 38·2 per cent. As to the comparative strength of ordinary copper, and that produced by electrolysis, Messrs. Goodwin & How carried out a series of tests, in which they found that the latter, even when deposited very slowly, was the weaker. When questioned by counsel at the trial as to the statement in "Electro-Deposition," that his electro-deposited copper stood a strain of 32 tons per square inch, Mr. Elmore at first stoutly and repeatedly denied that he had ever given me such information, but when confronted with the document, *in his own handwriting*, he was reluctantly compelled to admit its authenticity. This misleading statement, for which Mr. Elmore is solely responsible, called forth the following severe remarks from Mr. Justice Kay, when delivering his able and elaborate judgment:—"So that Mr. Elmore gave to Mr. Watt, and allowed to be published in the book, of which his son has a copy in court, this false statement about the breaking strain of copper tubes manufactured by him, and if he would do that, and if he had not the honesty to write to Mr. Watt and say he had made a mistake, and ask him to correct it, how can I doubt that he would tell the same falsehood to the persons who were engaged in this negotiation with him."

Alexander Watt.

December 5th, 1887.

Re The Lever Dynamo.

I had no desire to liken my drawings to your dynamo, but to call your attention to the facts that I have made both Pacinotti and Siemens armatures to run in laminated pole pieces. Then Mr. C. Lever says there is not a word in my specification that any projecting part of the armature revolve in the pole pieces. Surely Mr. Lever did not read my specification, lines 33, 34 and 35, which run:—"viz., that is to say strips of soft iron are employed of a reduced gauge or thickness compared with that adopted for the armature and so formed as to project into the air spaces between the discs of which the armature is composed." In conclusion I should like to tell Mr. C. Lever that if he did not invent the laminated Pacinotti ring to intersect the poles of a magnet three years ago, he is not the inventor, as I was about to take out a patent for it, but did not in my idea think it worth it, and I am still using the rings in either a plain or laminated pole piece. I did a lot of experimenting with these in the smaller sizes, viz., one iron stamping one copper in each space or groove of the pole piece, but as the field required an exciter I gave it up.

H. Jones.

December 5th, 1887.

Primary Batteries.

Mr. Hugh A. Fergusson, in his letter published in your issue of December 2nd, evidently overlooks the fact that I was not attacking the present position of the Lalande proprietors, but referring specially to Mr. Nursey's paper and to the programme of the original promoters of the battery. Mr. Nursey made a distinct claim on behalf of Mr. Berger Spence as being the originator of the recovery of zinc oxide from the exhausted solution, and did not even mention even zinc sulphide; and it will doubtless be within the recollection of your readers that the original prospectus of the Lalande Company, while affirming great things of the oxide, was equally silent respecting the sulphide. I have shown that the claims advanced by Mr. Nursey and the Lalande Company regarding the oxide are untenable.

In spite of all Mr. Fergusson has said, I am unable to persuade myself that De Lalande's patent was not inspired, in a degree at least, by my Glasgow philosophical paper. I put forward two principal novelties on that occasion: (1) The recovery of zinc oxide from exhausted caustic potash or soda solutions; (2) A voltaic battery, composed of iron or steel filings, borings or turnings, contained in an iron vessel with caustic alkali and zinc. I have already spoken of the fate of the first. That of the second was attended by a coincidence (?) just as remarkable, for, two months later, De Lalande filed a specification (No. 1,464, of 1882) for a caustic alkali and zinc battery, of which the following are extracts (the italics being mine): "The positive pole is formed by a plate of *iron*." . . . "This oxide of copper can be mixed with *iron filings* or *turnings*" . . . "in which is placed an *iron* rod or a rod of copper or carbon rod surrounded with *iron* or copper *turnings*."

I am not so illiberal as to imagine that an idea cannot occur to two or more persons simultaneously, but such an occurrence as this is at least remarkable.

A. R. Bennett.

December 6th, 1886.